Recent Results From DØ

G. Watts (University of Washington)

For the DØ Collaboration

ElectroWeak

QCD

Top

Higgs

Second Half of New Spring Results Presentation

Completing the SM

$\sigma(WH\rightarrow Wb\bar{b})$, $\sigma(Wb\bar{b})$ $\sigma(Zb)/\sigma$ (Zj), $\sigma(H\rightarrow WW^*)$, Single Top

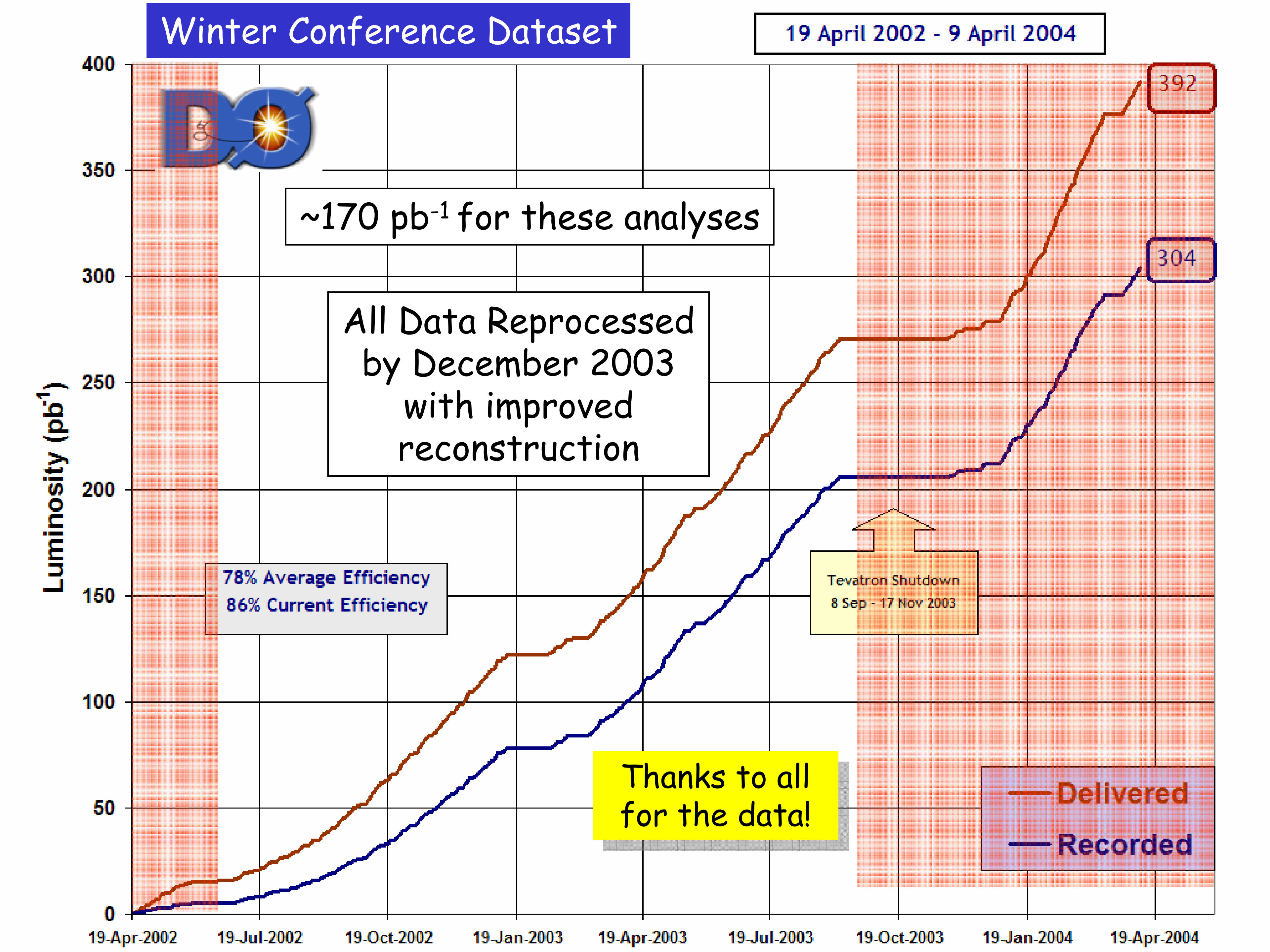
Precision Tests of the SM

$d\sigma/dp_T$, $d\sigma/dM_{jj}$, Azimuthal Jet Decorrelations, $\sigma(t\bar{t})$

Searches for physics beyond the SM

$\sigma(W\gamma)$, $\sigma(H\rightarrow\gamma\gamma)$, $\sigma(hb\bar{b})$

New Phenomena and B Physics – see talk by A. Nomerotski on March 26th…



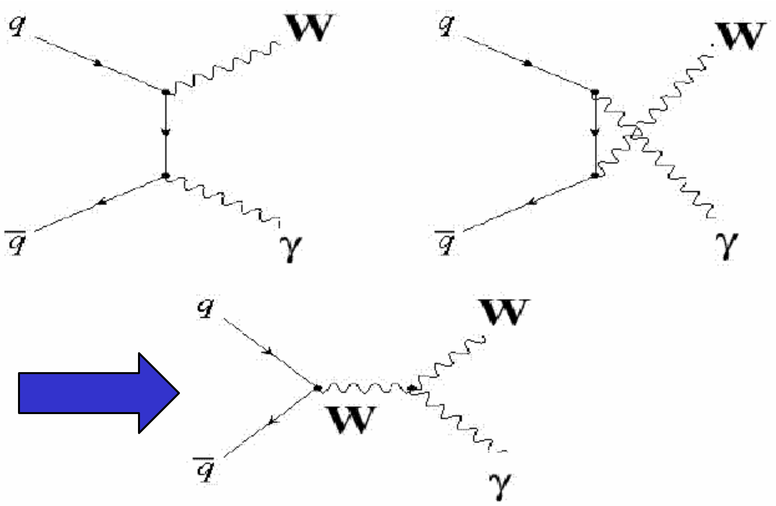
Winter Conference Dataset
19 April 2002 - 9 April 2004
~170 pb^{-1} for these analyses
All Data Reprocessed by December 2003 with improved reconstruction
78% Average Efficiency
86% Current Efficiency
Tevatron Shutdown
8 Sep - 17 Nov 2003
Thanks to all for the data!
392
304
Delivered
Recorded
Luminosity (pb^{-1})
0
50
100
150
200
250
300
350
400
19-Apr-2002
19-Jul-2002
19-Oct-2002
19-Jan-2003
19-Apr-2003
19-Jul-2003
19-Oct-2003
19-Jan-2004
19-Apr-2004

$W\gamma$ Cross Section

Trilinear Gauge Couplings

Small in SM
Sensitive to new Physics

$W\ p_T$ and $M_{W\gamma}$



Signature

e or μ and ν
and photon

Primary Background

W+Jets, jet fakes a γ.

e channel: 162.3 pb^{-1}
μ channel 82.0 pb^{-1}

$W\gamma$ Backgrounds

W+Jets

Jet fakes a photon
Determine photon fake rate from data
- 0.3% - 0.1 % for 10 GeV to 50 GeV jets

Expected Background Event Counts

	e	μ
W+Jets	80.0 ± 7.4	31.0 ± 10
leX	3.7 ± 0.5	0.6 ± 0.6
$Z\gamma$	-	4.7 ± 2.0
$W\gamma \rightarrow \tau\nu\gamma$	3.4 ± 1.1	0.9 ± 0.3
Total	*87.1 ± 7.5*	*37.0 ± 10*

leX

Lepton + electron with out track + missing E_T
- tt, etc.

Use sample of events with good electron and apply tracking efficiency.

$Z\gamma$, τ's

- MC based

Wγ Results

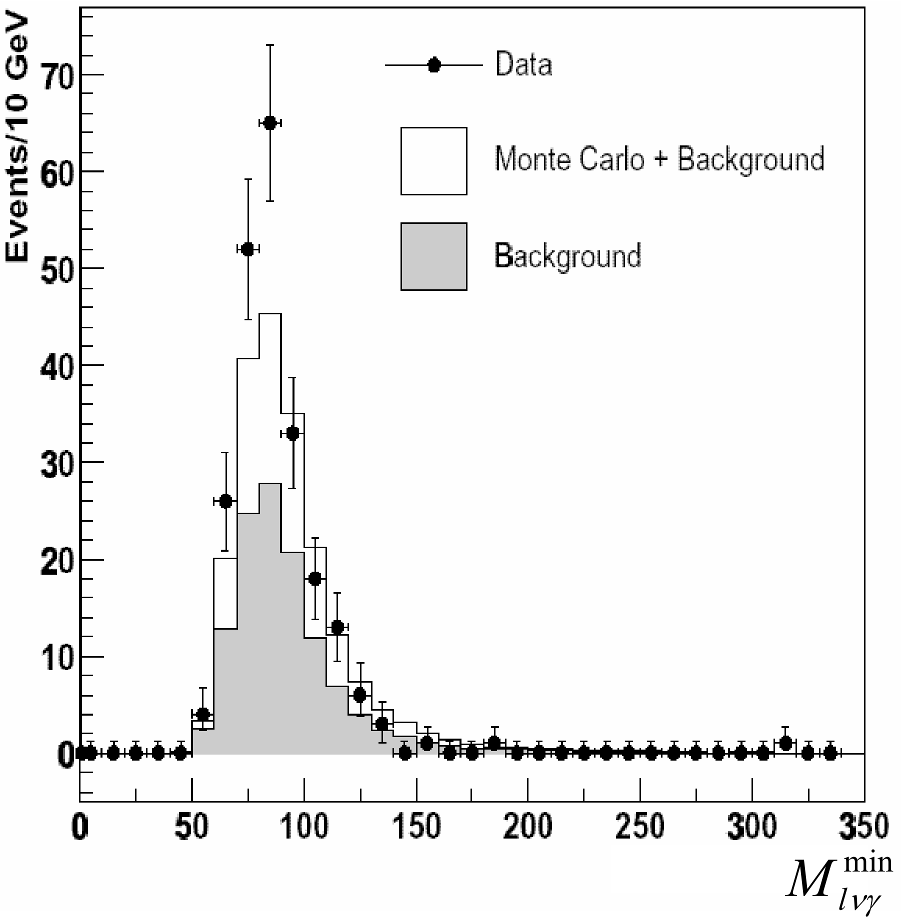
	$W \rightarrow e\nu$	$W \rightarrow \mu\nu$
Background Expected	87.1 ± 7.5	37 ± 10
Observed	146	77

$\sigma(pp \rightarrow W\gamma \rightarrow l\nu\gamma + X)$
19.3 ± 6.7 ± 1.2(lumi)

Signal Eff calculated using Baur MC + Pythia

First Step…

With increased data detailed Wγ kinematic studies will be possible



QCD Inclusive Jet and Dijet Cross Sections

Reliable Test of NLO Perturbative QCD

- Jet Evolution, Parton Distribution Functions, new physics at α_s.
- Traditional place to search for new physics
  - Quark Compositeness, etc.

Run 2 Datasets

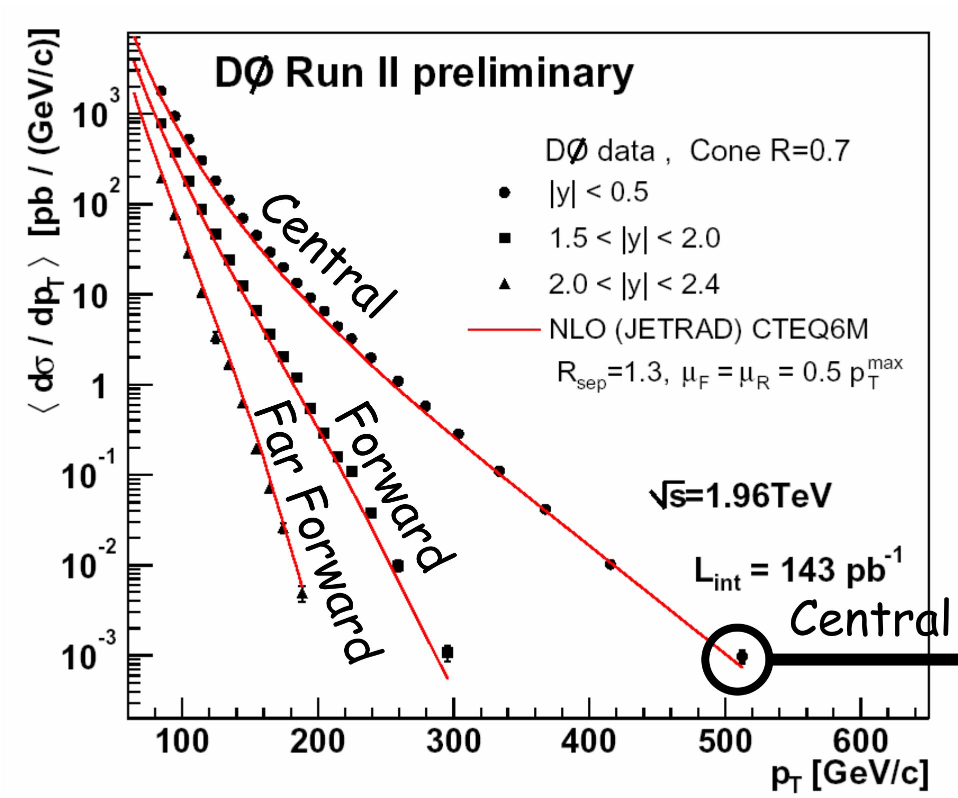
- Better discrimination of PDFs

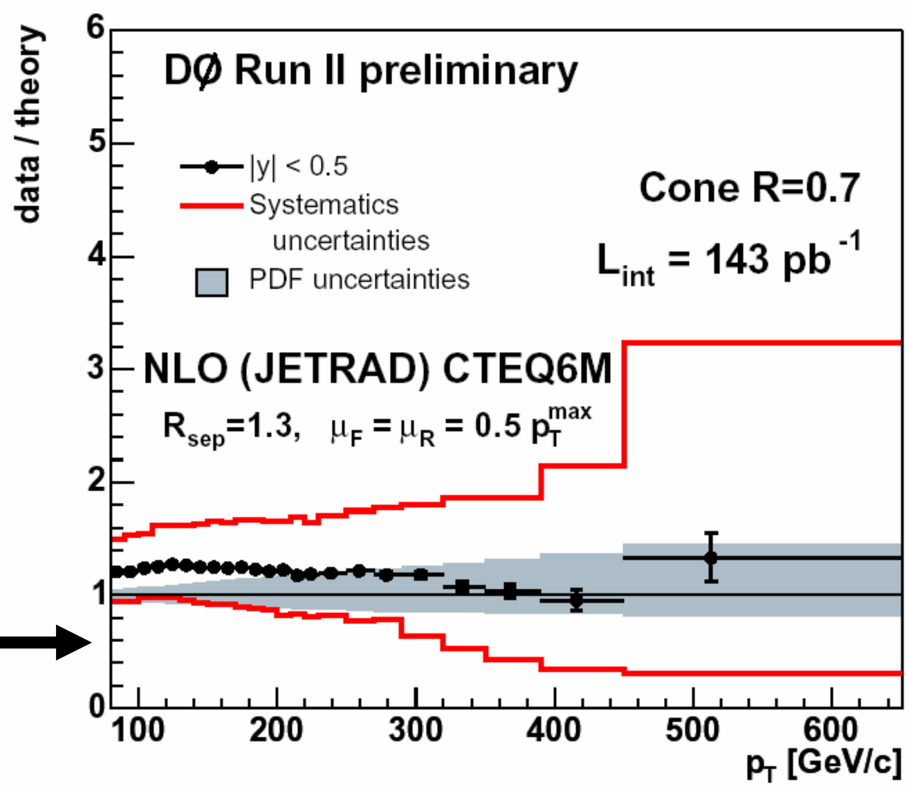
Jet Energy Scale is largest systematic error

Look at both Forward and Central Regions

- *Central Region* – large transverse energy – most sensitive to new physics and PDFs
- *Forward Region* – Less sensitive to new physics, but still sensitive to PDFs

$d\sigma/dp_T$

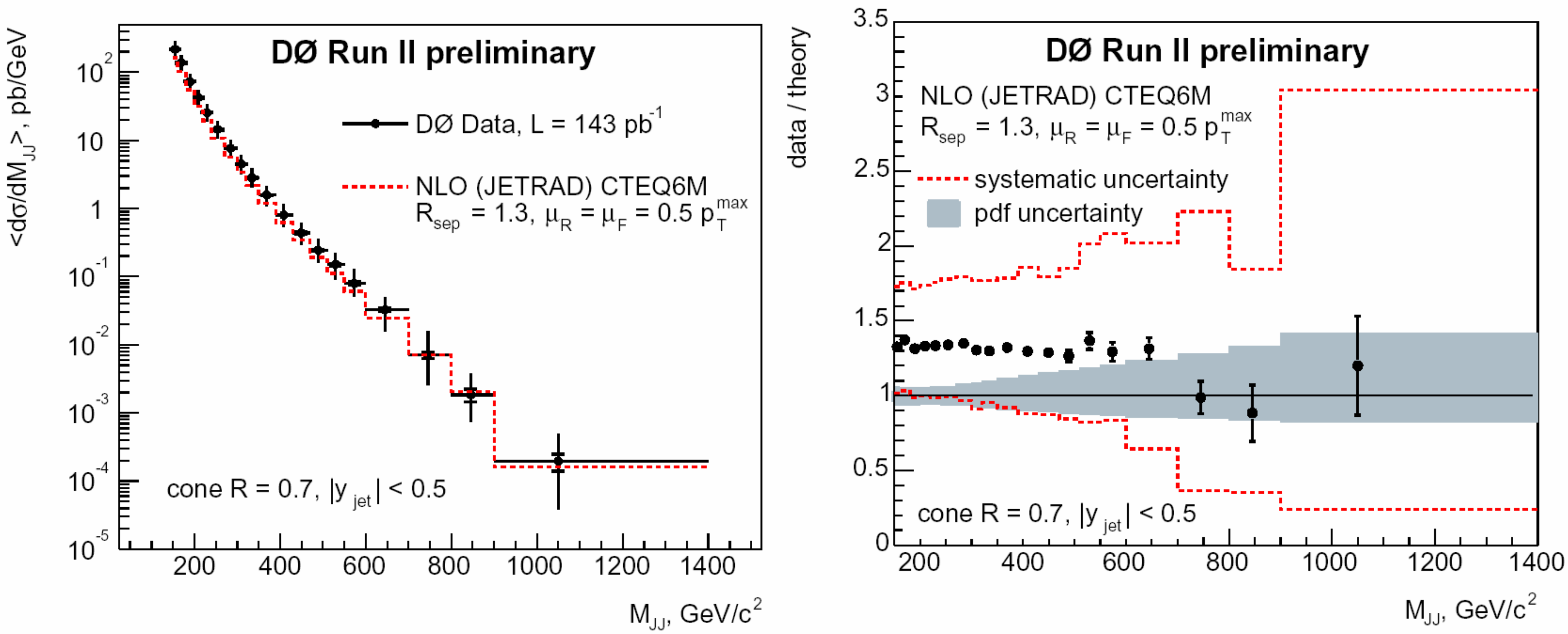




Similar, with larger errors, for other eta regions

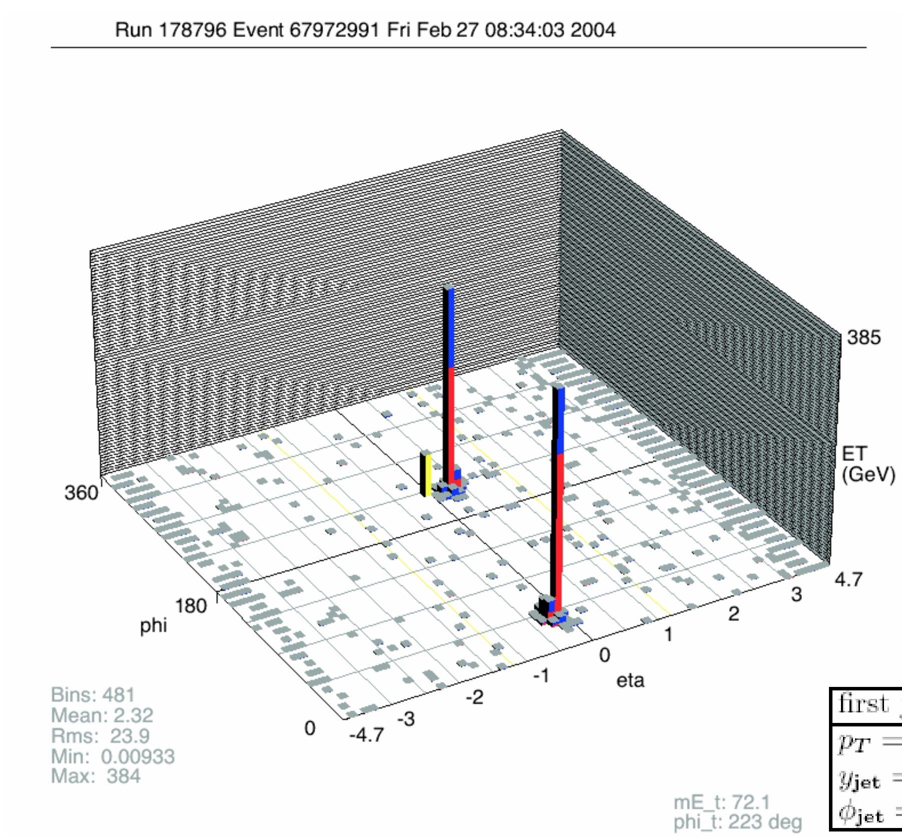
Stay tuned for improvements to JES

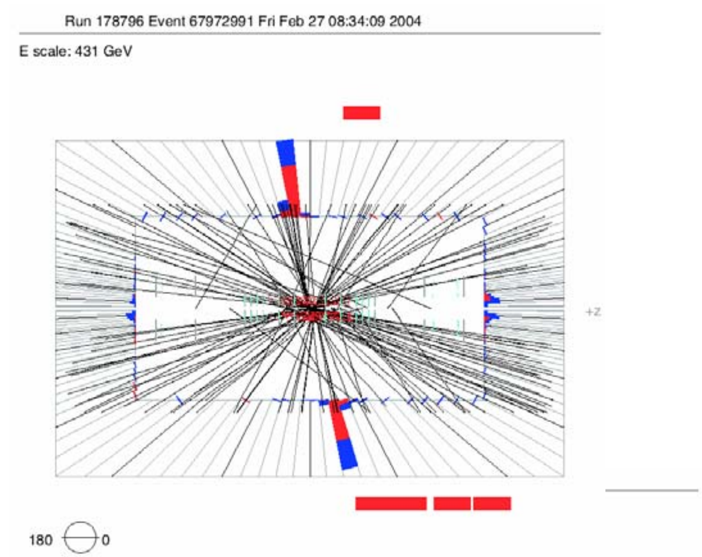
M_{jj}



DØ Run II preliminary
DØ Data, L = 143 pb-1
NLO (JETRAD) CTEQ6M
Rsep = 1.3, μR = μF = 0.5 pTmax
cone R = 0.7, |y jet| < 0.5
<dσ/dMJJ>, pb/GeV
MJJ, GeV/c2
DØ Run II preliminary
NLO (JETRAD) CTEQ6M
Rsep = 1.3, μR = μF = 0.5 pTmax
systematic uncertainty
pdf uncertainty
cone R = 0.7, |y jet| < 0.5
data / theory
MJJ, GeV/c2

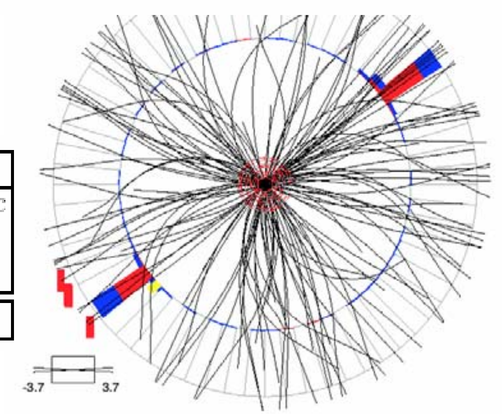
The "Biggest" QCD Event





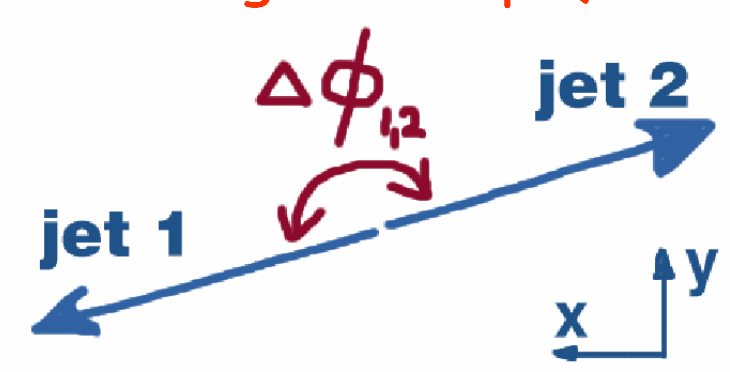
first jet	second jet
$p_T = 616\,\mathrm{GeV}/c$ $y_{\mathrm{jet}} = -0.19$ $\phi_{\mathrm{jet}} = 0.65$	$p_T = 557\,\mathrm{GeV}/c$ $y_{\mathrm{jet}} = 0.25$ $\phi_{\mathrm{jet}} = 3.78$

$M_{jj} = 1206\,\mathrm{GeV}/c^2$



Jet Azimuthal Decorrelations

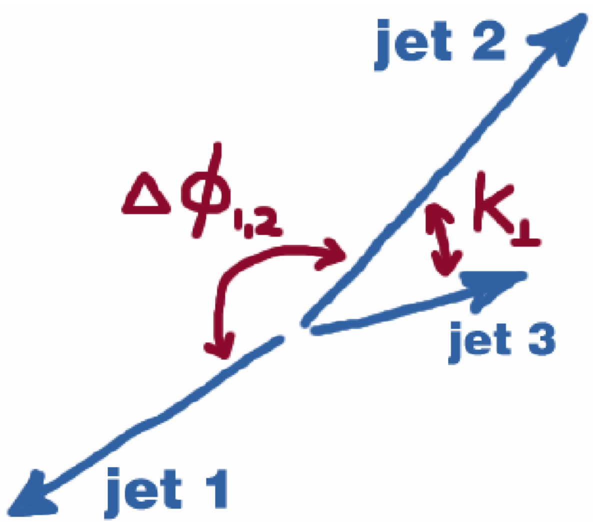
Leading Order pQCD



Jets are back-to-back

$\Delta\phi_{12} = \pi$

3 jets in pQCD



$\Delta\phi_{12} < \pi$

$$\lim_{p_{T3} \to 0} \Delta\phi_{1,2} = \pi$$

$\Delta\phi_{12}$ is sensitive to jet formation without having to measure 3rd jet directly!

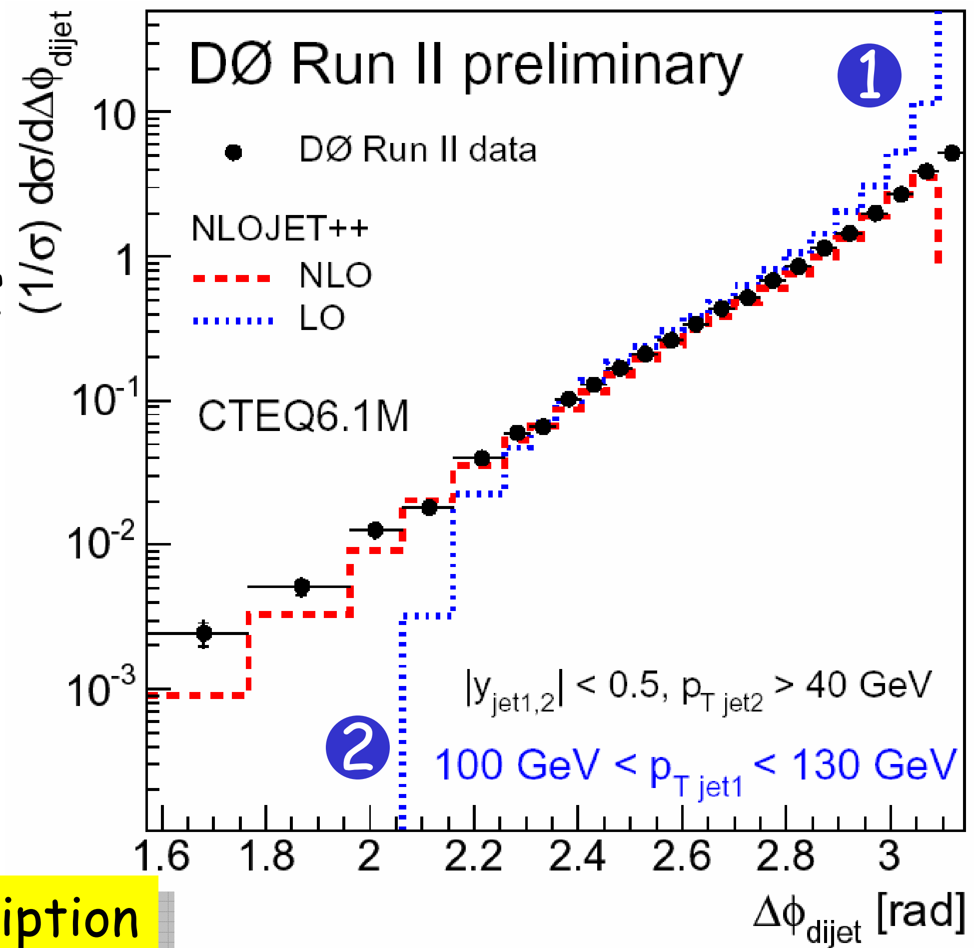
Jet Azimuthal Decorrelations

Look at events with 2 jets

Measure $\Delta\phi_{dijet}$

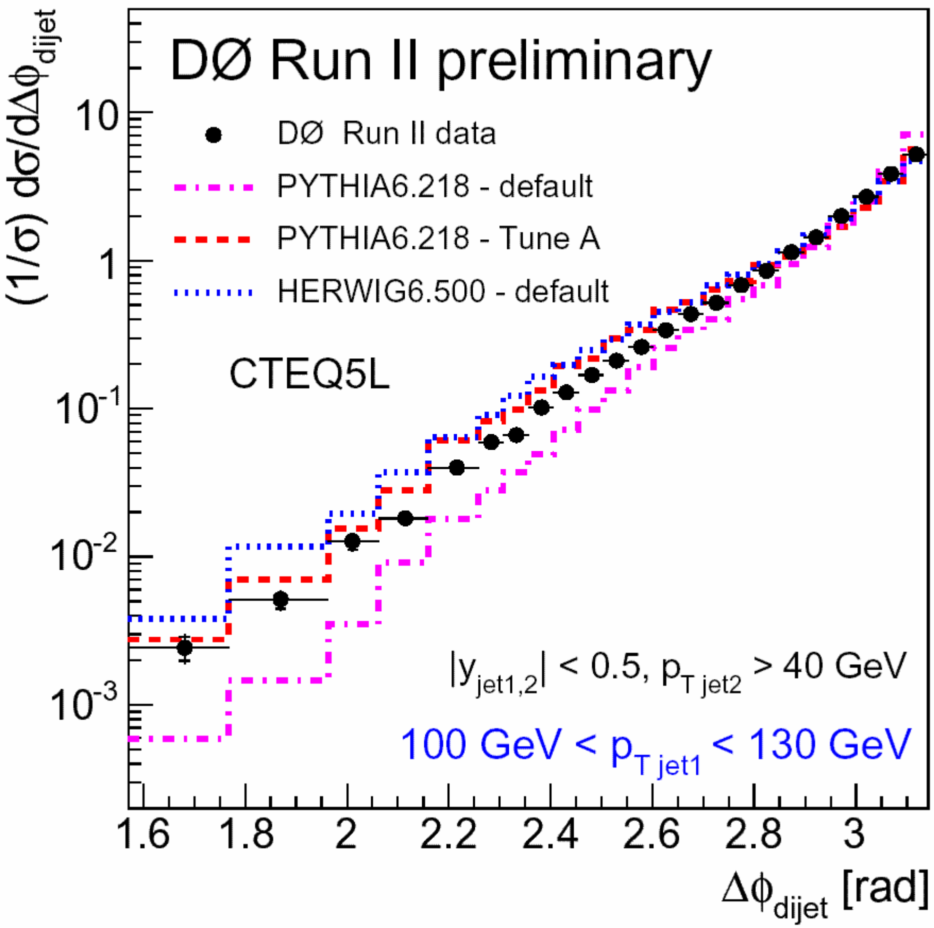
Compare to a LO & NLO MC

1. LO MC 3 jet production has pole as $p_T^3 \rightarrow 0$
2. LO MC 3 jet $\Delta\phi_{dijet} > 2\pi/3$



Not compatible with a LO description

Jet Azimuthal Decorrelations



Further tests of MC Model

ISR rate in MC has strong effect on matching as well.

Important for $t\bar{t}$, H mass, etc.

More data, better JES will continue to improve the power of this measurement.

Non SM H $\rightarrow \gamma\gamma$

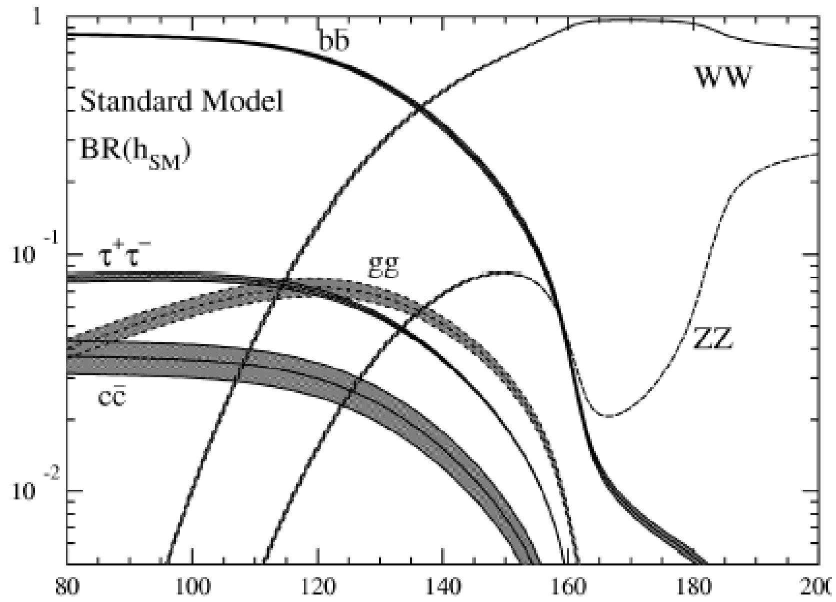
SM H $\rightarrow \gamma\gamma$

Branching Ratio is small, 10^{-3}, 10^{-4}

Beyond SM Suppress Higgs Products

Fermiphobic or Top Color Higgs

BR(H $\rightarrow \gamma\gamma$) enhanced

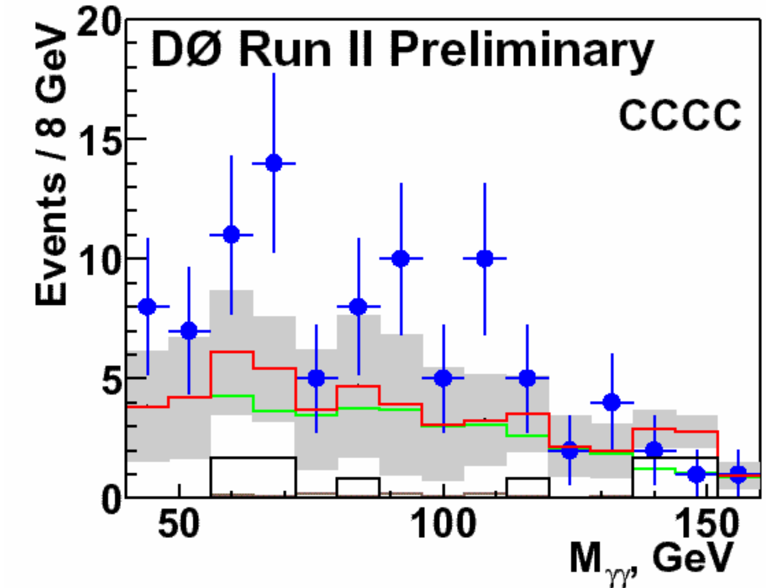


Require 2 isolated EM Objects
p_T>25 GeV

Backgrounds

Z/y ee – (data)
$\gamma\gamma$ production (MC)
QCD w/jets misidentified (data)

Non SM H → γγ



Look for resonance in $M_{\gamma\gamma}$

None found, so set limits…

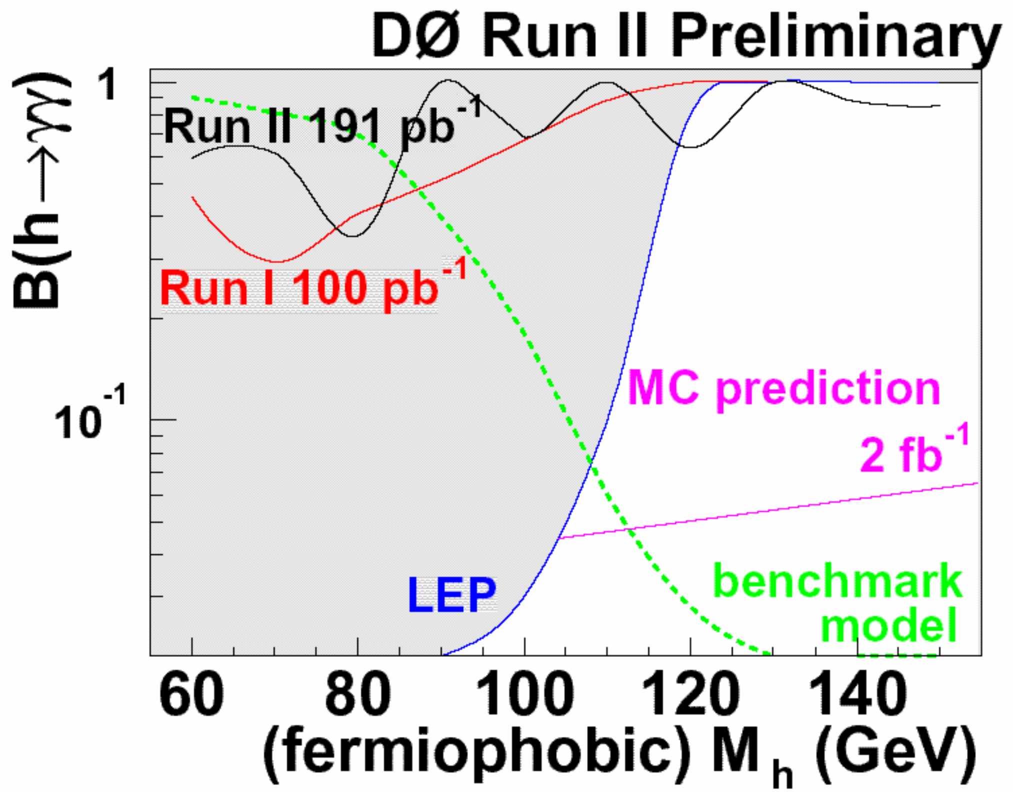
Systematic Errors

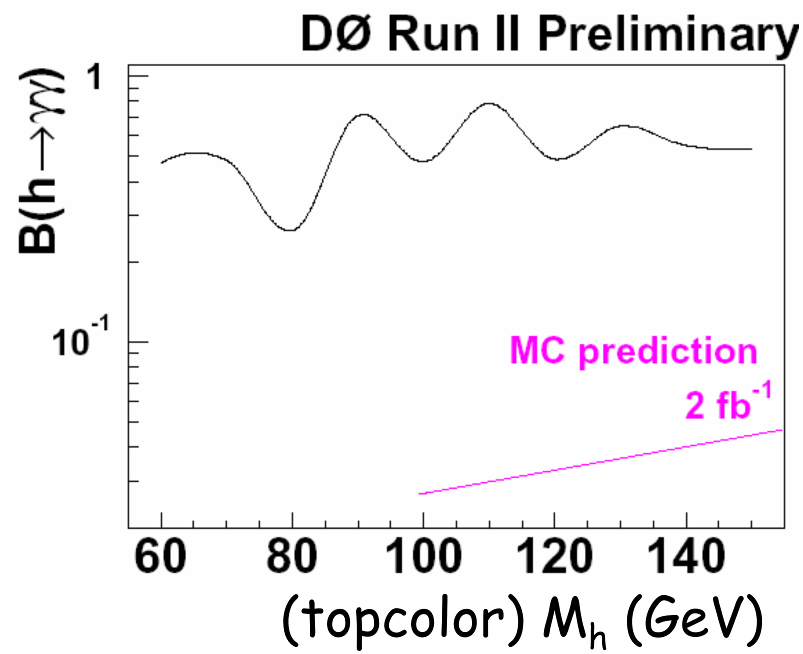
Dominated by Luminosity determination
And photon fake rate determination

Split the detector by regions according to fake rates

	Data	Total BKG	QCD	DY	gg
CCCC	93	54.4 ± 28.0	42.7 ± 28.0	1.4 ± 1.3	8.3 ± 0.6
CCEC	97	68.8 ± 45.8	64.0 ± 45.7	3.0 ± 3.0	1.8 ± 0.1
ECEC	41	20.8 ± 10.4	13.1 ± 10.0	6.7 ± 3.0	1.0 ± 0.1

Non SM $H \rightarrow \gamma\gamma$



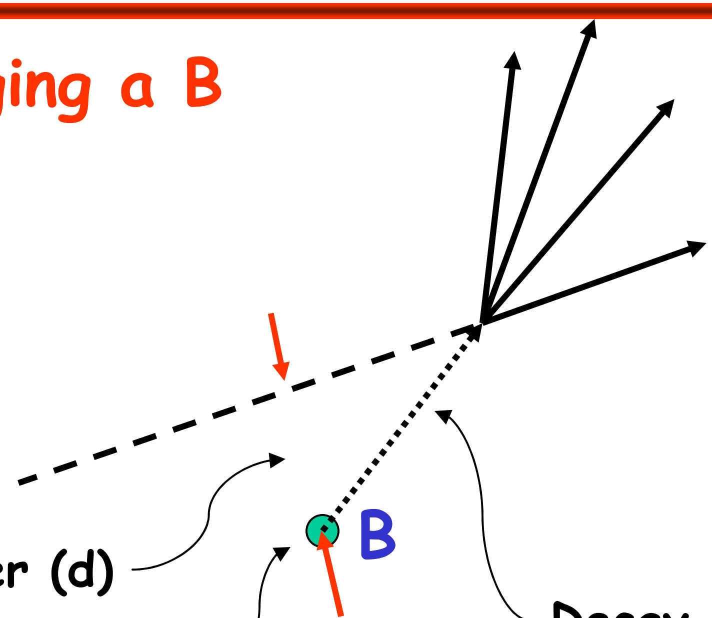


Fermiophobic model from A. G. Akeroyd, Phys Rev. Lett. 368, 89 (1996)

Analysis improvements possible by making use of CPS, etc.

Tagging a B

Vertex Tagging a B



- Top, Higgs contain b-quark jets
  - Most backgrounds do not
- Leptons from B meson
- Contain a B meson
  - Has finite life time
  - Travels some distance from the vertex before decaying
    - ~ 1mm
    - With charm cascade decay, about 4.2 charged tracks

Several algorithms under active development

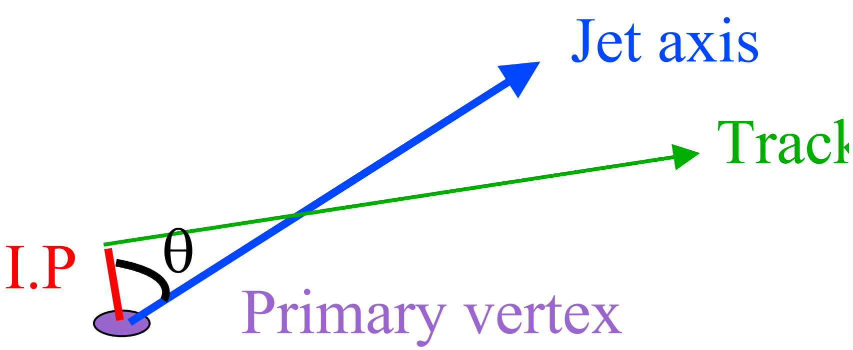
Impact Parameter Resolution	$d/\sigma(d)$
Decay Length Resolution	$L_{xy}/\sigma(L_{xy})$

CSIP Algorithm

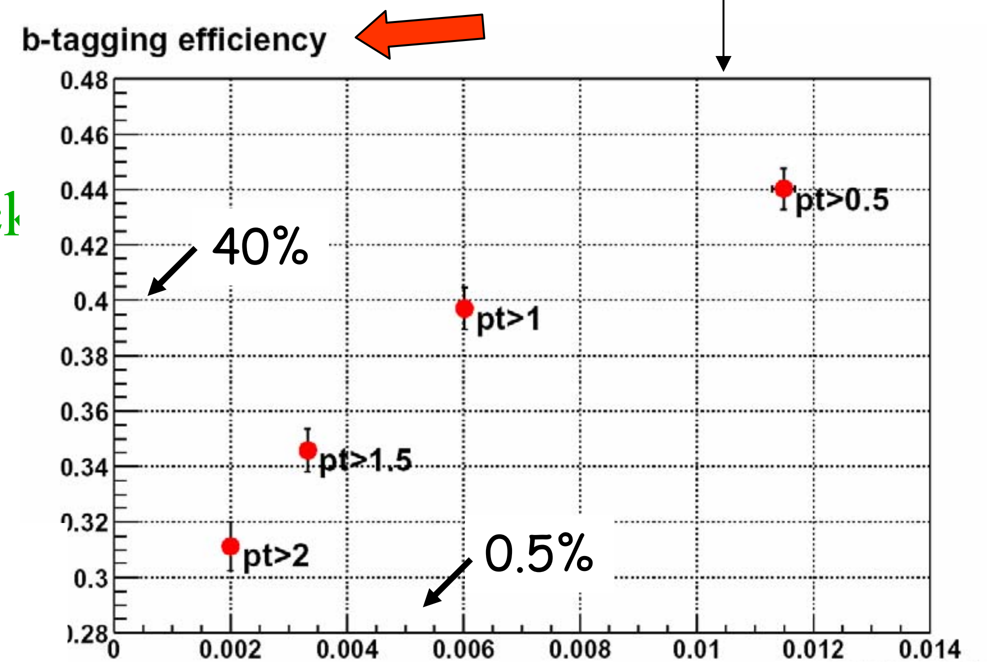
Counting Signed Impact Parameter

Based on Impact Parameter Significance

$S(IP) = IP/\sigma(IP)$



Per Taggable Jet Rates Measured in Data!



Light Quark Fake Rate

Requirements to tag a jet:
- at least 2 tracks with S(IP) > 3
- or at least 3 tracks with S(IP) > 2

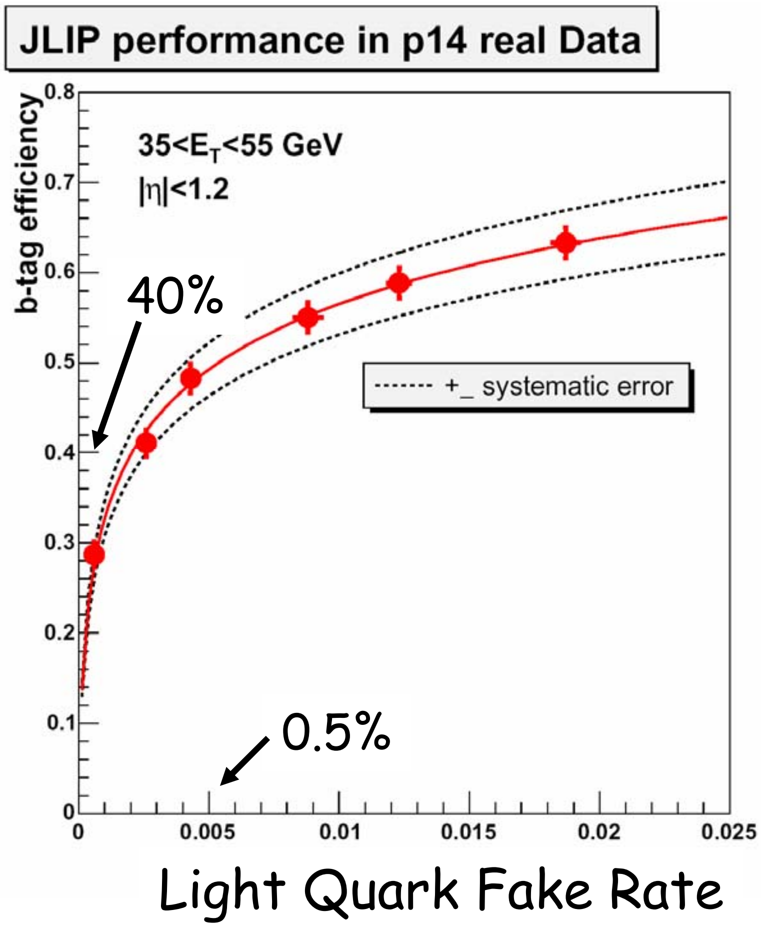
JLIP Algorithm

Jet Lifetime Impact Parameter

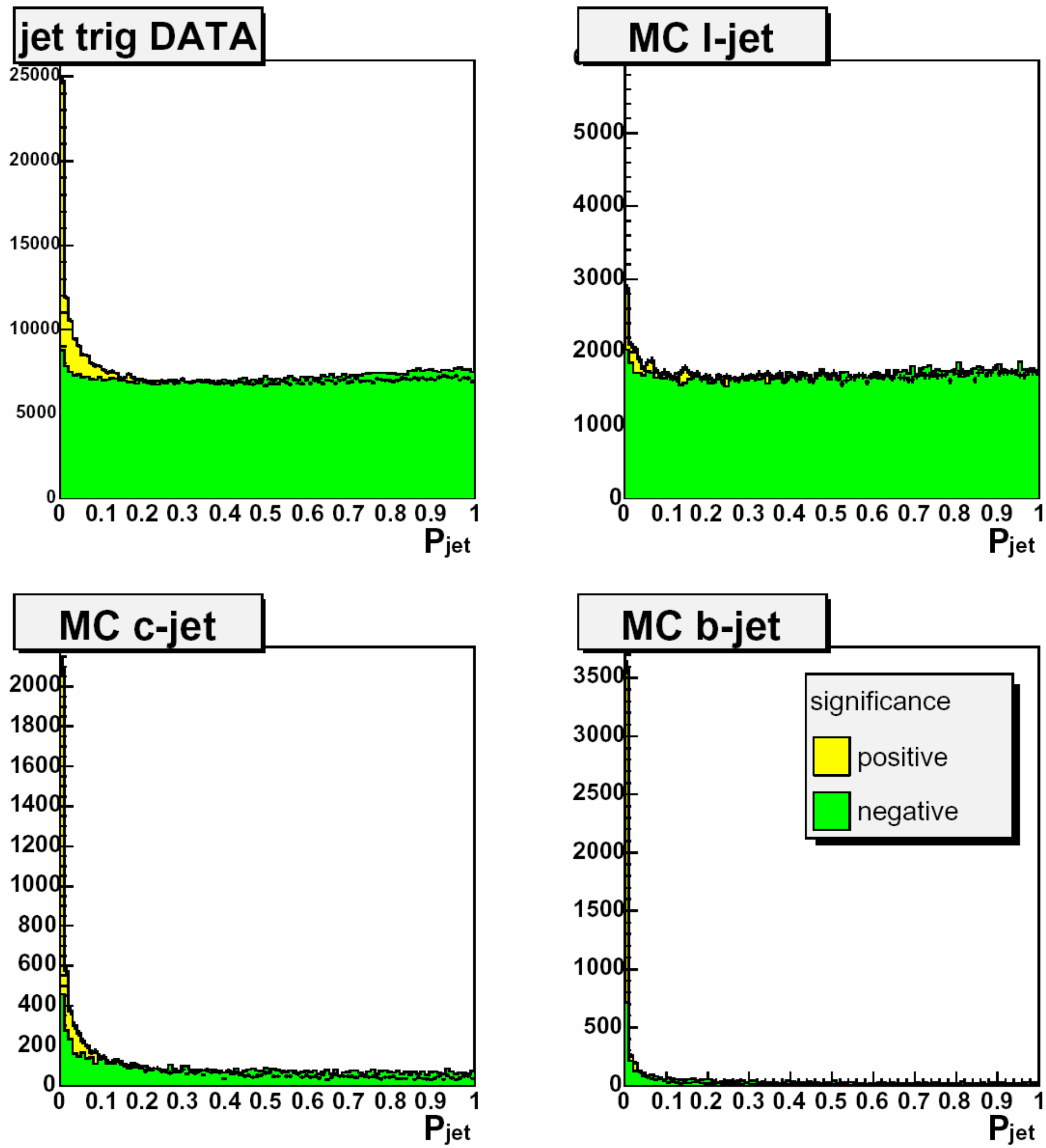
Based on Impact Parameter Significance

Probability distributions
- P(Track from PV)
  - Defined for each class of tracks
    - # of SMT Hits, p_T, etc.

Each jet assigned P(light quark)



jet lifetime probability (p1403)

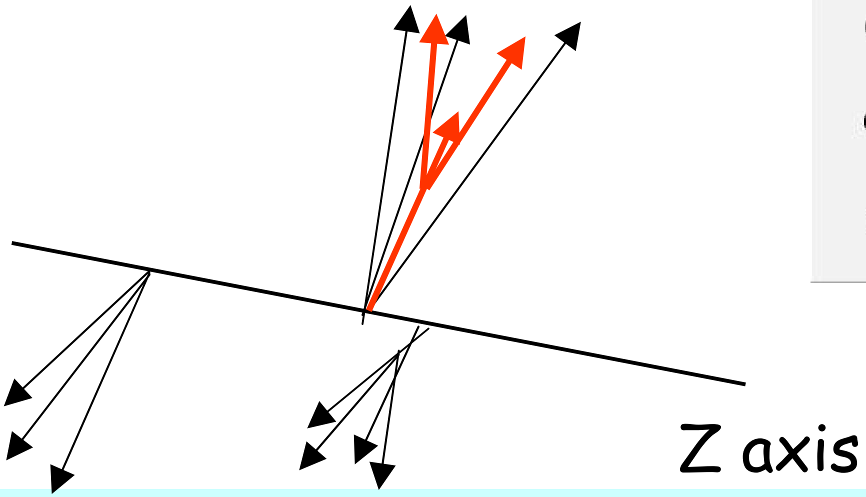


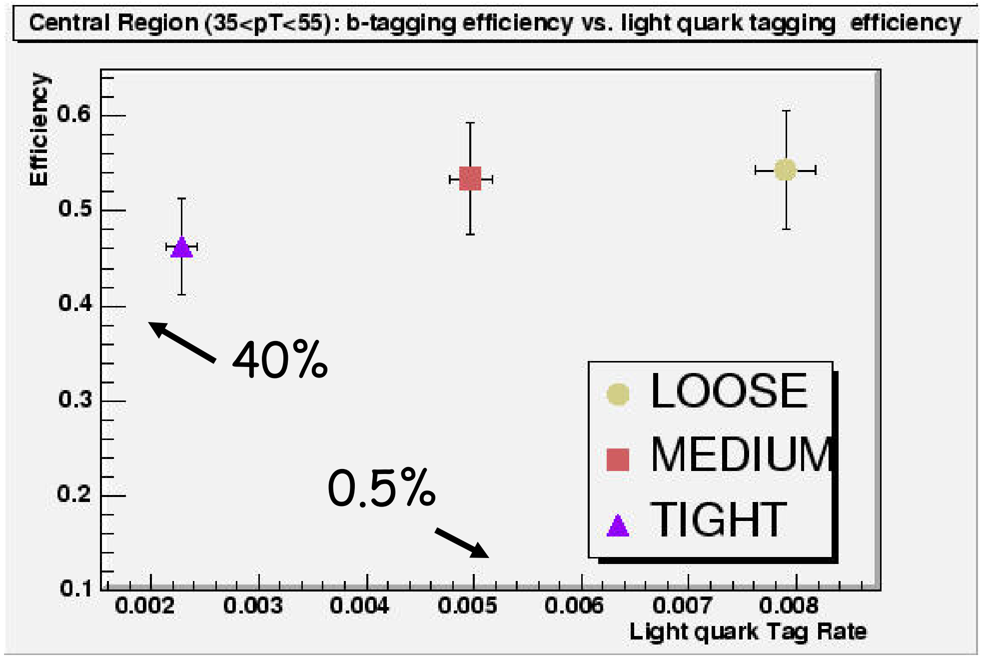
SVT Algorithm

Secondary Vertex Tagger

- Reconstruct Vertices using displaced tracks
- Cut on Decay Length Significance

$S(L_{xy}) = L_{xy}/\sigma(L_{xy})$.





B Tagging

Performance on signal

tt lepton+jets ~ 56%
Single Top (s channel) ~ 52%
Wbb ~ 52%
Wj ~ 0.3%

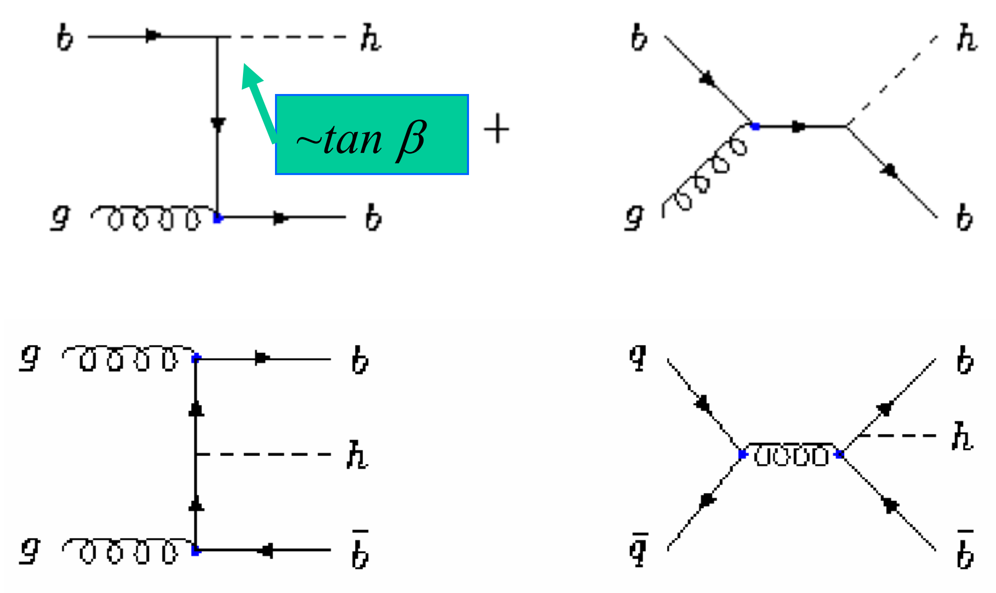
Combining the Taggers

Already studied the correlations
Working now on making a combination

Higgs Production at Large *tan*β

MSSM

- Low *tan* β, $\rightarrow$ Standard Model Higgs
- High *tan* β, $\rightarrow$ enhanced *bbH*
  - Cross section rises like ***tan***$^2\beta$
- ***Substantial improvements in Theory understanding since Run 1***



Use 3 b-tags

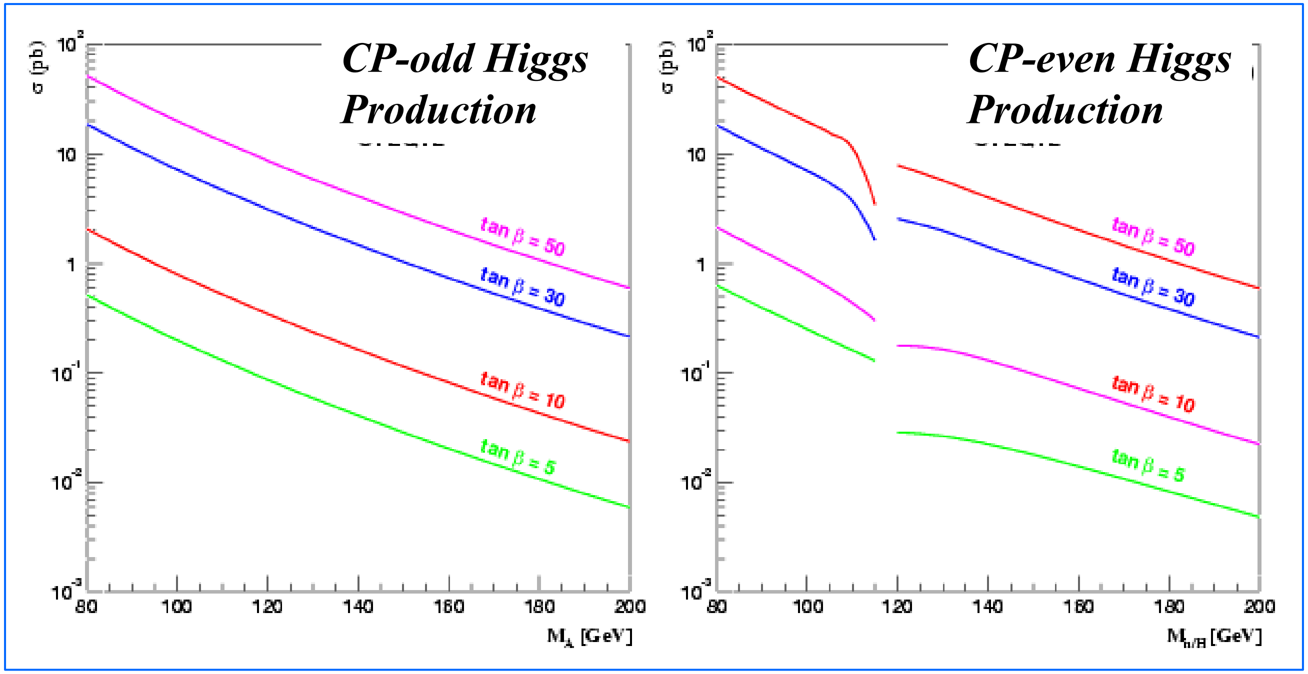
Backgrounds Include:

QCD: bbh, bbjj, bbbb
EW/St: Zb, Z, tt

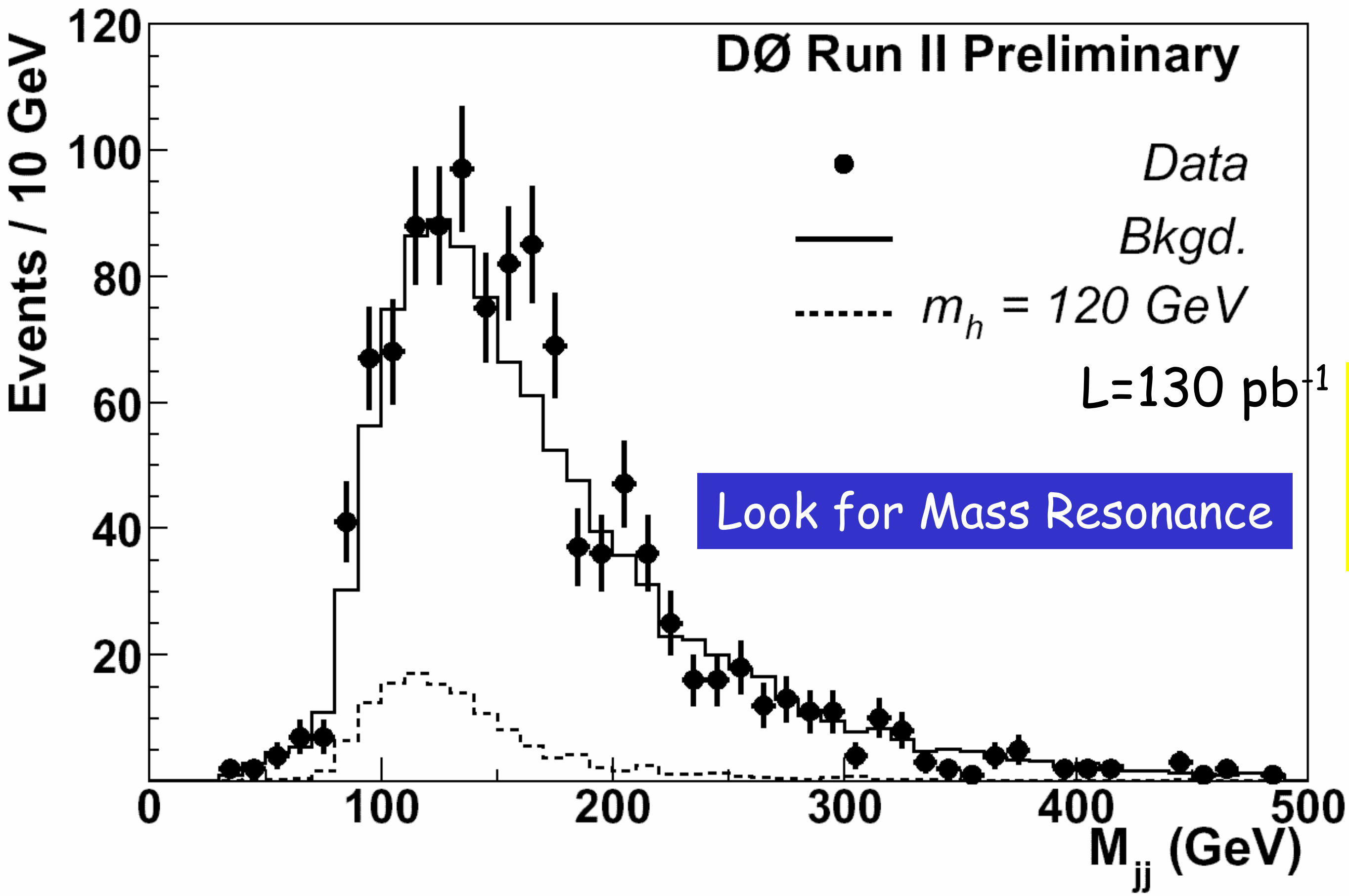
4 Jet HF MC QCD not well tested: design around its use

Look for excess in di-jet mass window

Use shoulders to calibrate


CP-odd Higgs Production
CP-even Higgs Production
σ (pb)
tan β = 50
tan β = 30
tan β = 10
tan β = 5
M_A [GeV]
M_h/H [GeV]

Higgs Production at Large *tanβ*



Trigger on 3 jets + ~60% efficiency

3 Jets In Event 20, 15, 15 GeV

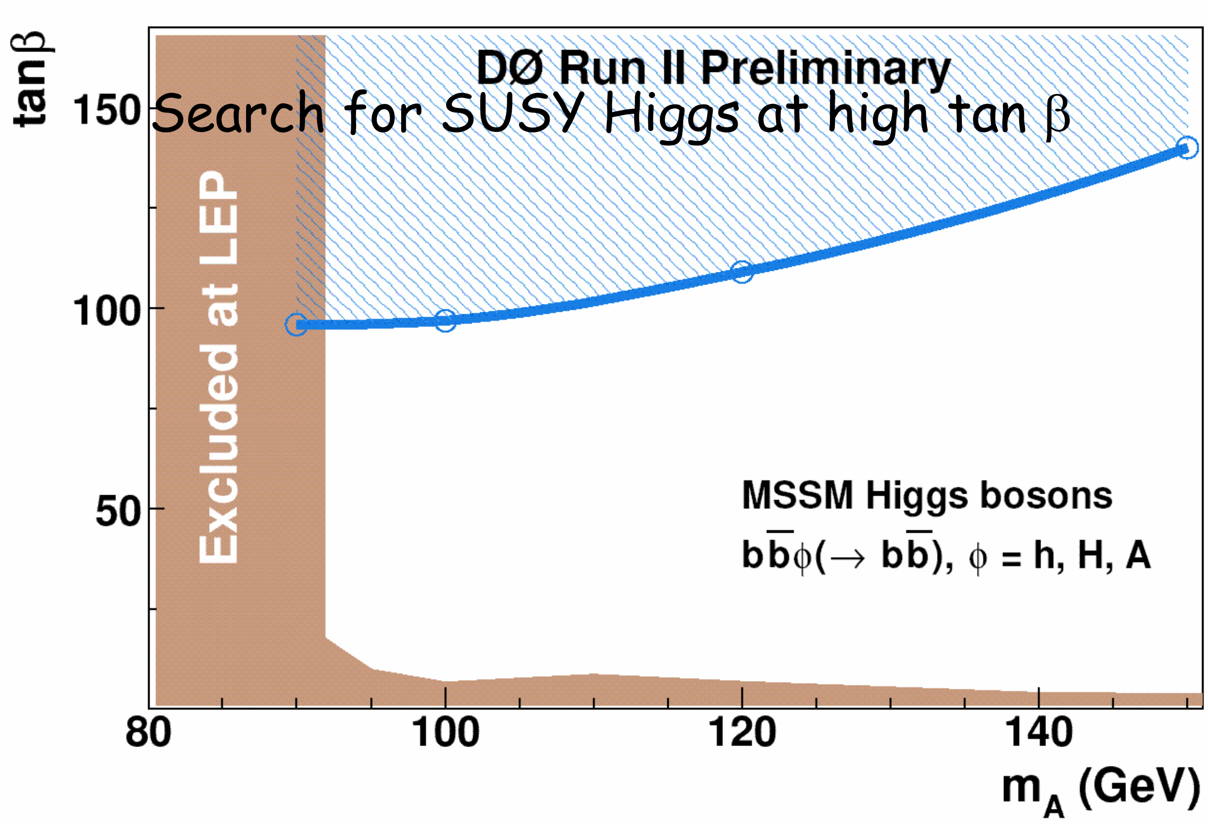
Background shape determined from data

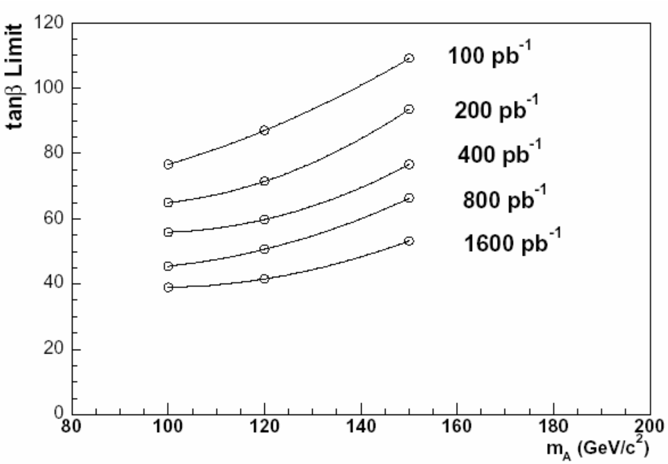
Normalization determined by fitting to region ±1σ from expected higgs signal

Results

- Set limit using fitted distributions (TLimit)
- Will be down at 40 with M_A=100 at 1.6 fb^{-1}
  - No analysis improvements taken into account!

Search for SUSY Higgs at high tan β





Higgs Decays

Search strategies are a function of Decay Channel and Production Channel

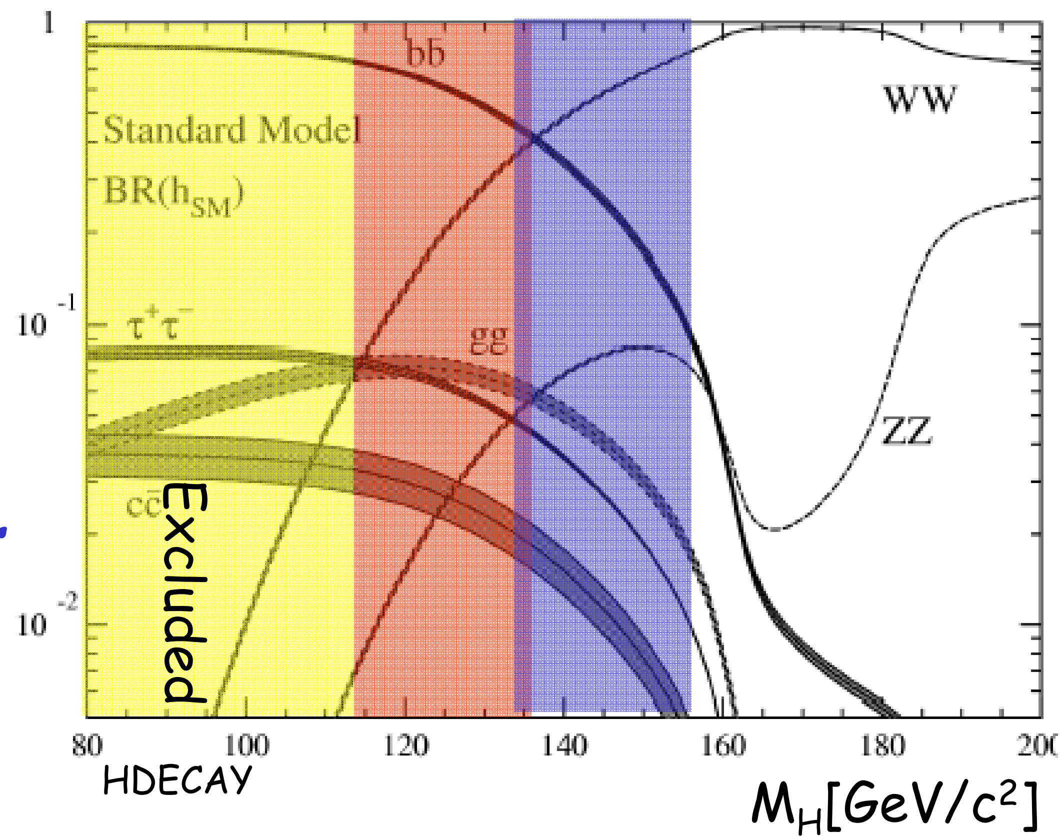
Nominal Mass Reach Spans Two Decay Modes

Low Mass Higgs Searches

$$m_H < 135 GeV/c^2$$
$$H \rightarrow b\bar{b}$$

High Mass Higgs Searches

$$m_H > 120 GeV/c^2$$
$$H \rightarrow WW^*$$



Higgs Production

Gluon Fusion

$gg \rightarrow H \quad \sigma \sim 1pb$

No Good at Low Mass

Overwhelmed by QCD background

Good at High Mass

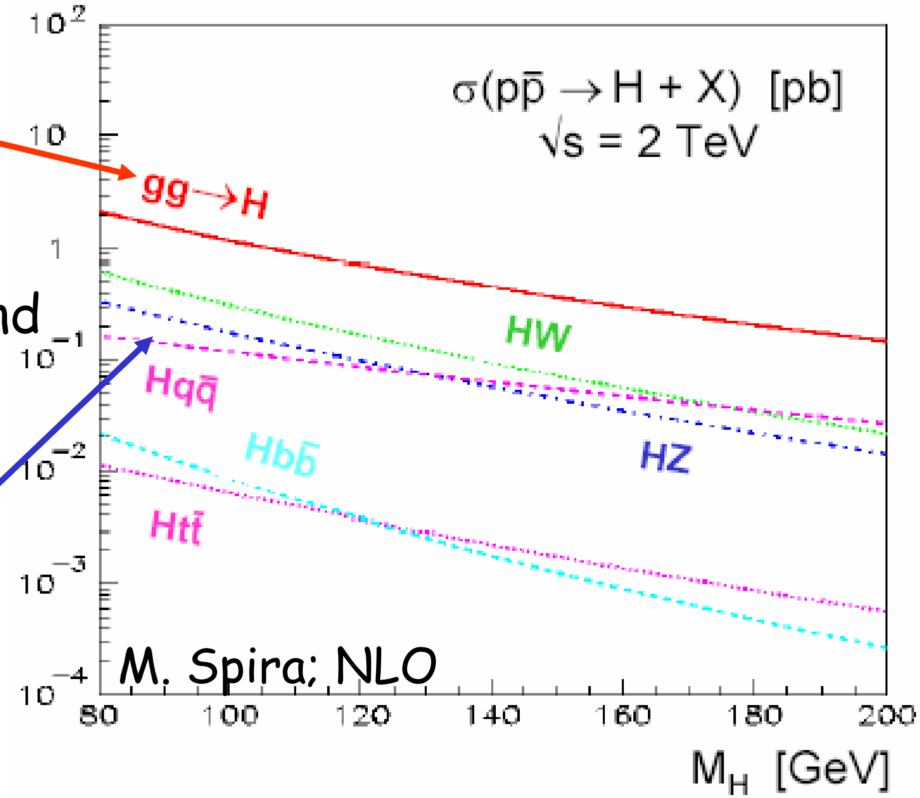
$H \rightarrow WW^{*}$

Associated Production

ZH, WH $\quad \sigma \sim 0.1pb$

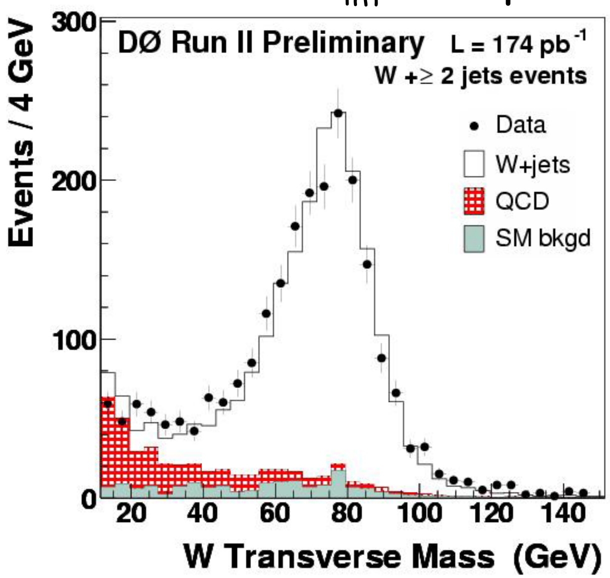
Good at Low Mass

$H \rightarrow b\bar{b}$

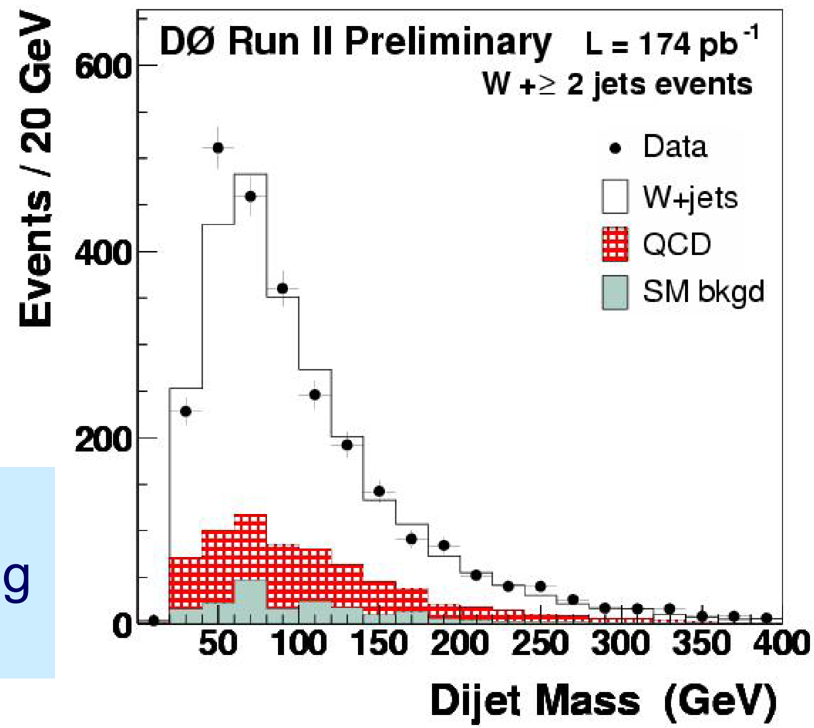


Wbb, electron channel

- Same final state as WH
  - One of background processes
- Event selection include
  - Central isolated e, p_T > 20 GeV
  - Missing E_T > 25 GeV
  - ≥ two jets: E_T > 20 GeV, $|\eta|$ < 2.5
- 2587 evts. in L_{int}=174 pb^{-1} of data



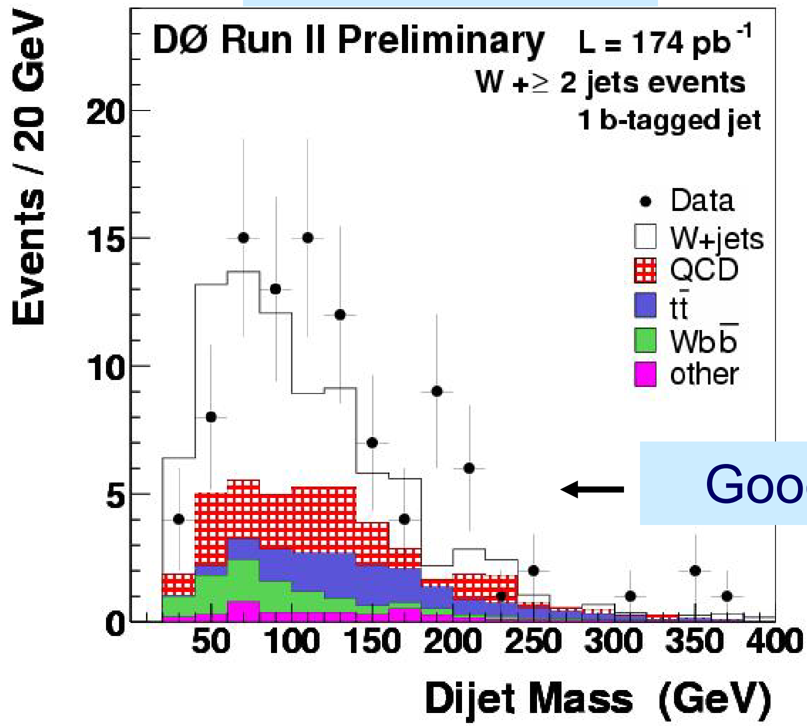
Fair understanding of data



- Simulations with Alpgen plus Pythia through detailed detector response
- Cross sections normalized to MCFM NLO calculations

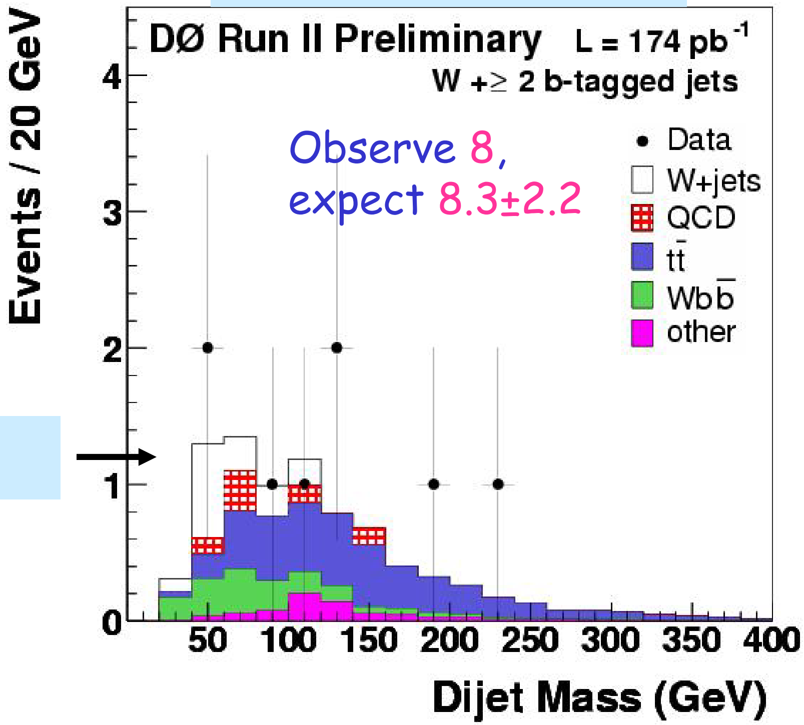
Wbb, B Tagging

At least one b-tag



Good agreement

At least two b-tags

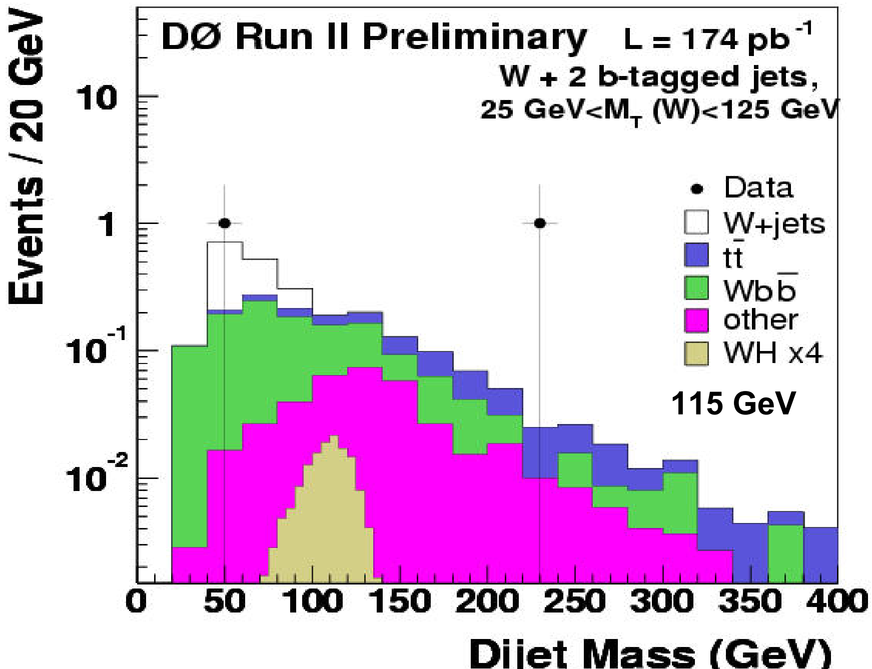


Suppress Top Production

Require N_J = 2, 3-tag algorithm

Observe 2 evts, expect 2.5±0.5

Wbb and WH Limits



Source	Uncertainty (%)
Jet energy scale	14
Jet ID	7
b-tagging	11
Trigger & e ID	5
EM scale	5
MC simulations	15
Total	***26***

Wbb	Wc(c)	Wjj	tt+t	Others
1.4±0.4	0.3±0.1	0.1±0.03	0.6±0.2	0.1±0.03

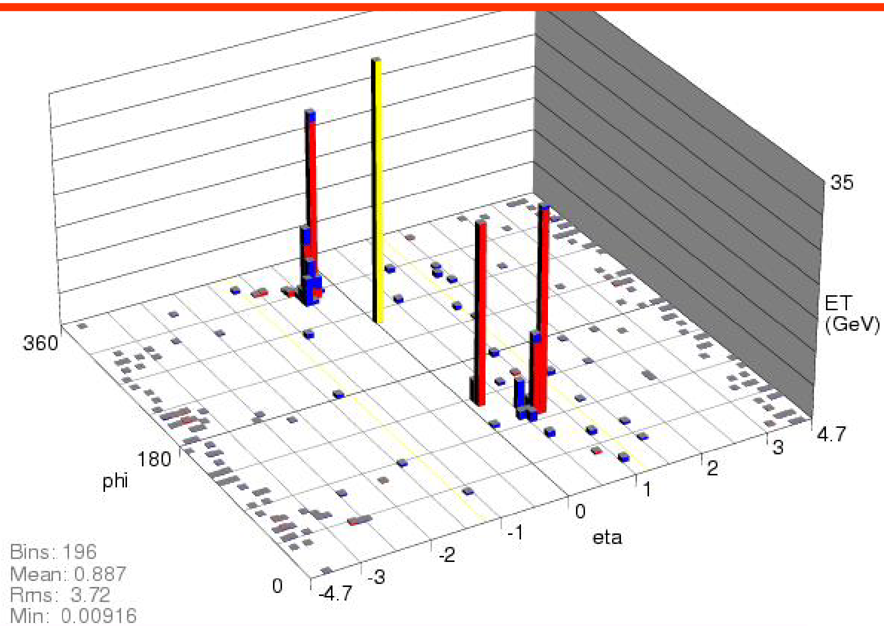
Before Tag

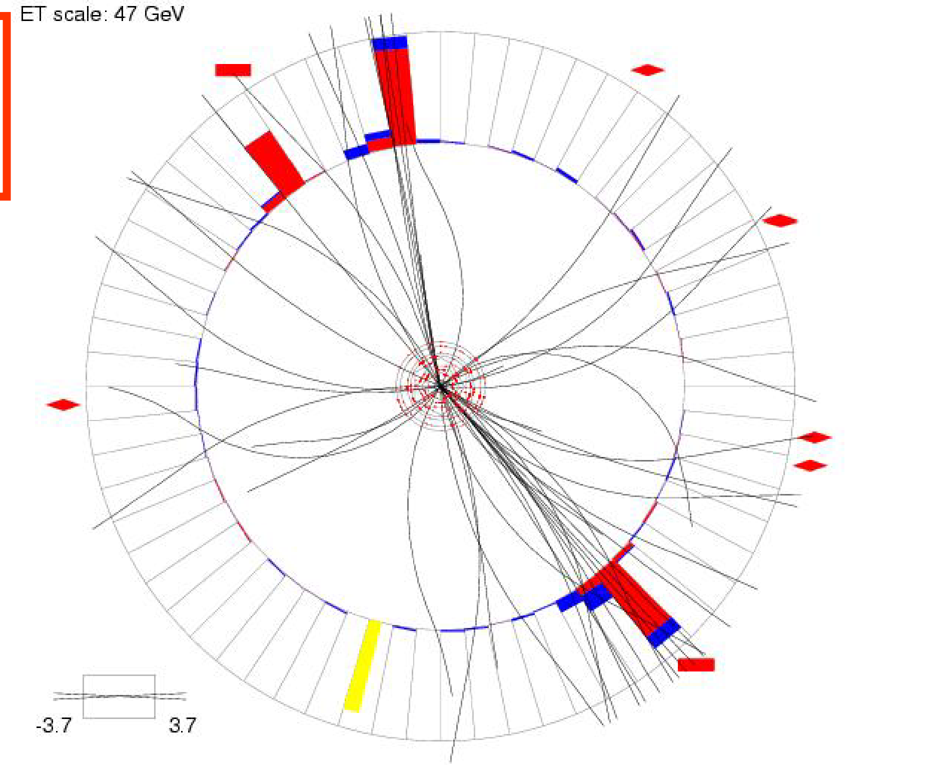
For WH limit use mass window. Expect 0.03 WH, 0.54 from SM backgrounds, observe 0

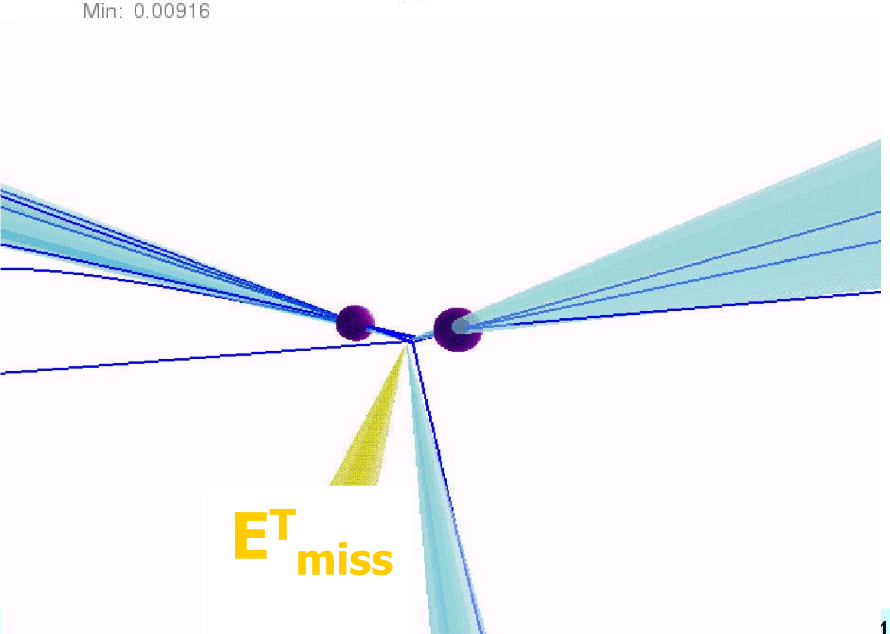
σ(Wbb) < 20.3 pb
Prefer Wbb at 2σ

σ(WH)B(H$\to$bb) < 12.4 pb
(M_H = 115 GeV/c^2)
@ 95% C.L.

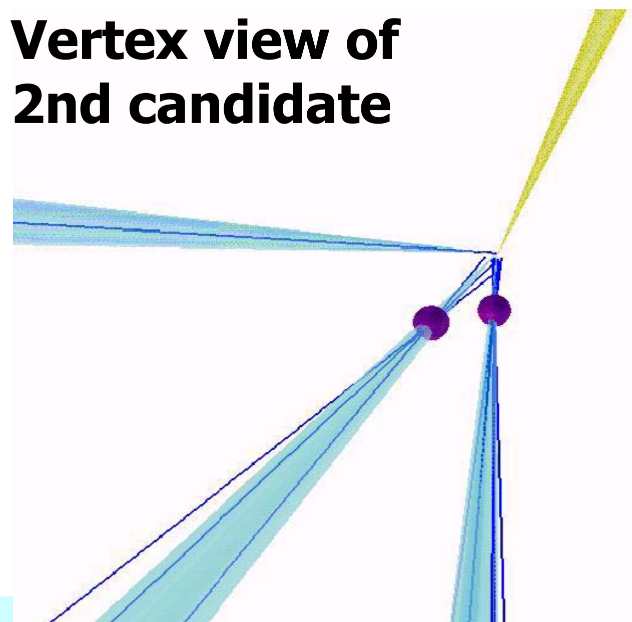
3 views of high dijet mass (220 GeV) Wbb (WH) candidate







Vertex view of 2nd candidate

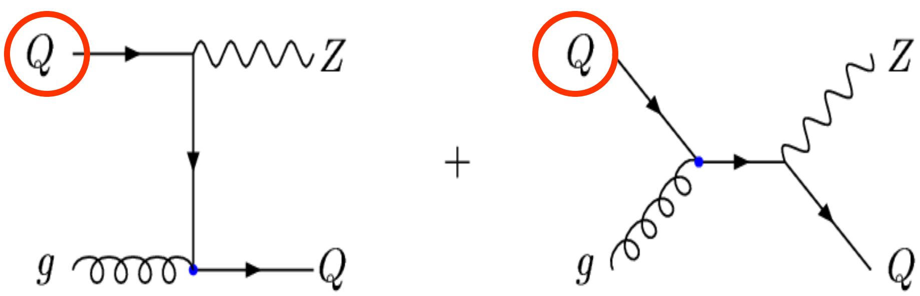


dijet mass (48 GeV)

$Z(\rightarrow ee/\mu\mu)b$

- Background to ZH production
- Benchmark for SUSY Higgs production via gb→bh
- Probes PDF of the b-quark

Isolated e/m with p_T > 15/20 GeV, $|\eta|$ < 2.5/2.0
Z peak for signal, side bands for bkgd. evaluations
Jet ET > 20 GeV, $|\eta|$ < 2.5
At least one b-tagged jet



L=184 (ee), 152 ($\mu\mu$) pb^{-1}

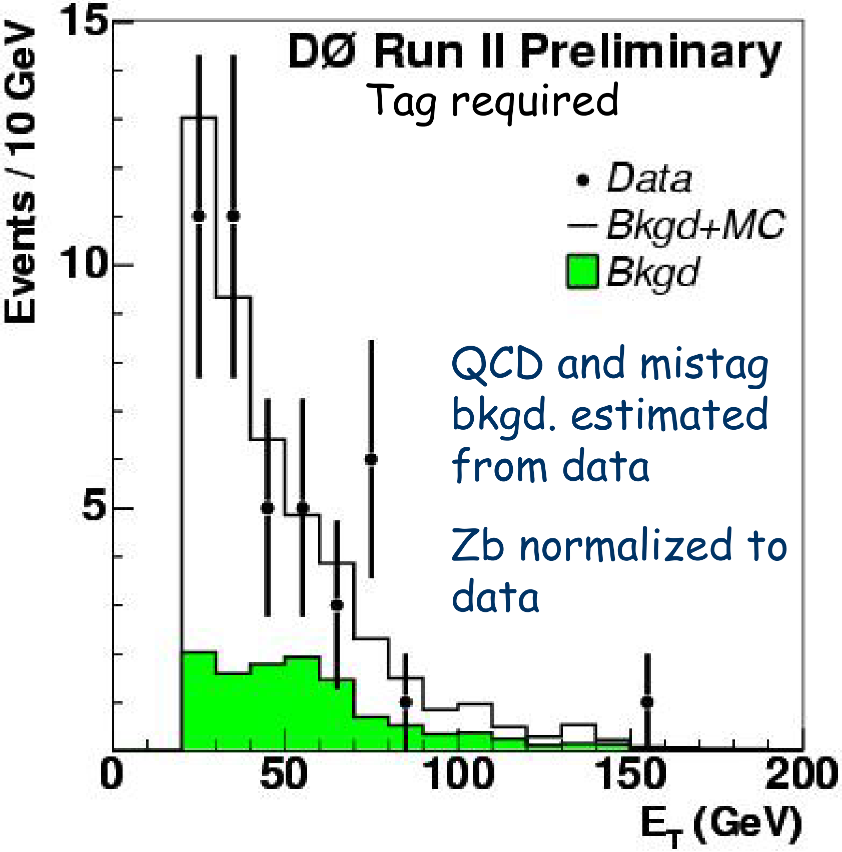
Jet Flavor Content Calculated with MCFM (NLO)
b/c Ratio

Measure cross section ratio
$\sigma(Z+b)/\sigma(Z+j)$
Many uncertainties cancel

Background

QCD and Z/γ

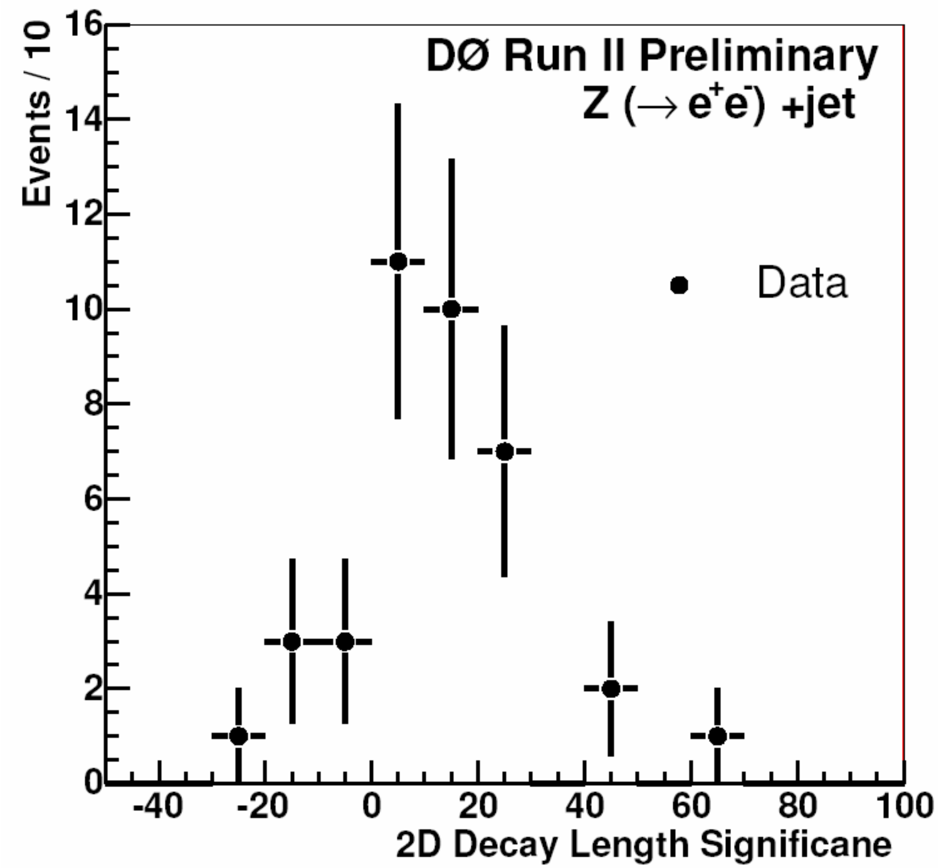
Z(→ee/μμ)b



QCD and mistag bkgd. estimated from data

Zb normalized to data

Good Match to MC



Clear Indication of Heavy Flavor

$$R = \frac{\sigma(p\bar{p} \to Zb)}{\sigma(p\bar{p} \to Zj)}$$

Source	Uncertainty (%)
Jet tagging	16
Jet energy scale	11
Bkgd. estimation	6
σ(Z+c)/σ(Z+b)	3
Total	***20***

$$R = 0.024 \pm 0.005(stat)^{+0.005}_{-0.004}(syst)$$

Theory

J. Campbell, R. K. Ellis, F. Maltoni, S. Willenbrock

hep-ph/0312024

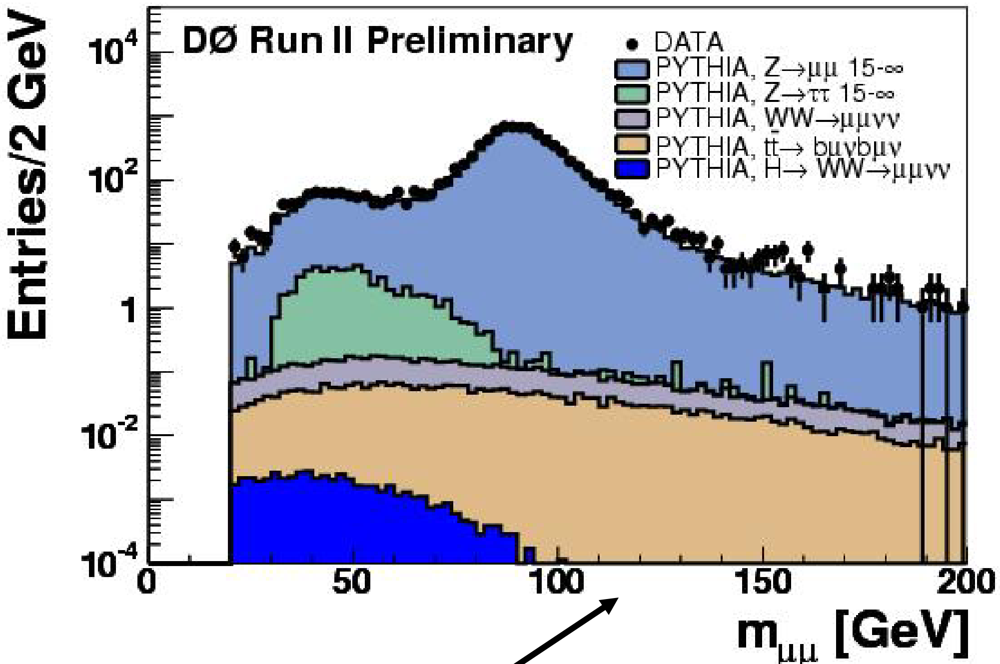
R~0.02

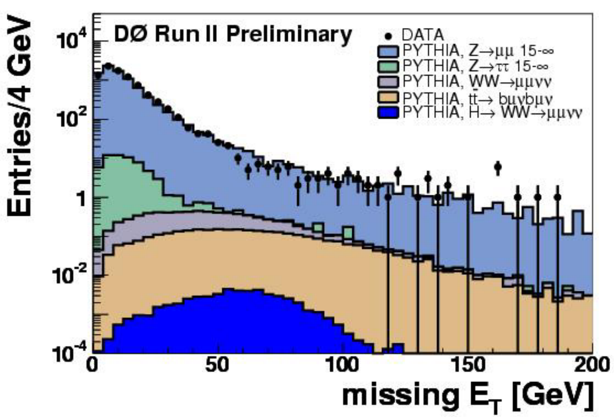
High Mass SM Higgs Search

$H \to WW^{(*)} \to l^+l^-\nu\nu$

- Event selection include
  - Isolated e/μ
    - $p_T(e_1) > 12$ GeV, $p_T(e_2) > 8$ GeV
    - $p_T(e/\mu_1) > 12$ GeV, $p_T(e/\mu_2) > 8$ GeV
    - $p_T(\mu_1) > 20$ GeV, $p_T(\mu_2) > 10$ GeV
  - Missing E_T greater than
    - 20 GeV (ee, eμ); 30 GeV (μμ)
  - Veto on
    - Z resonance
    - Energetic jets

L = 180 (ee), 160 (eμ) and 150 (μμ) pb^{-1}



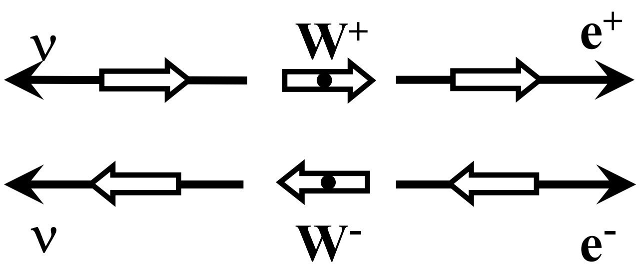


μμ Channel

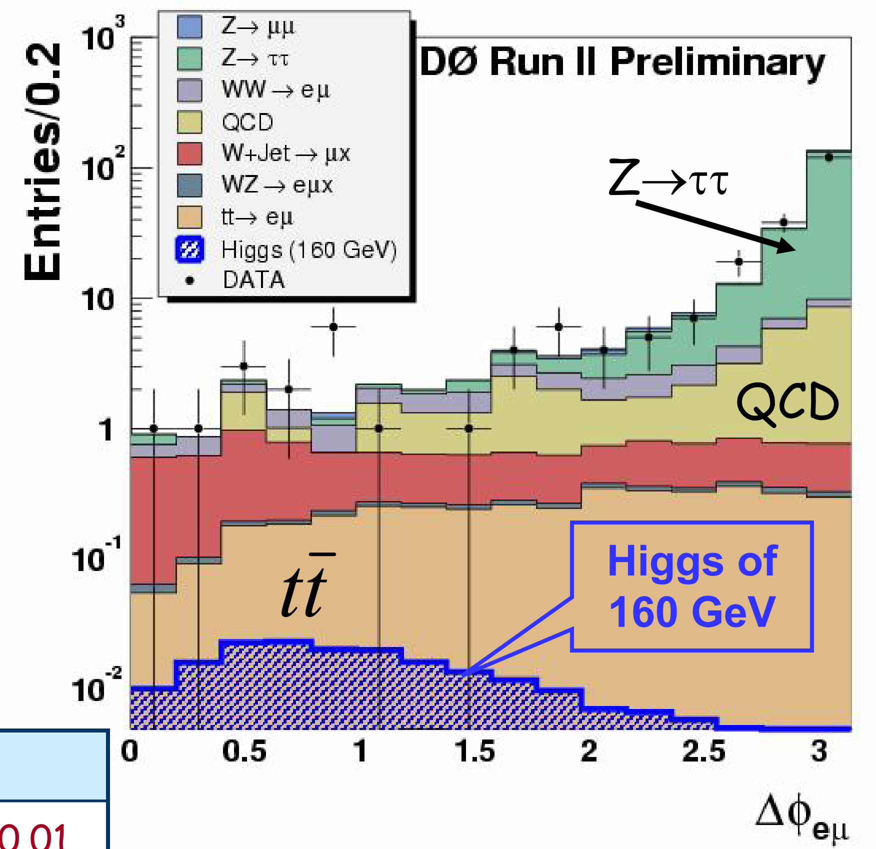
$H \to WW^{(*)} \to l^+l^-\nu\nu$

Spin Correlations

$\Delta\phi(ll)$ – Azimuthal Angle



Leptons from Higgs Tend to be collinear

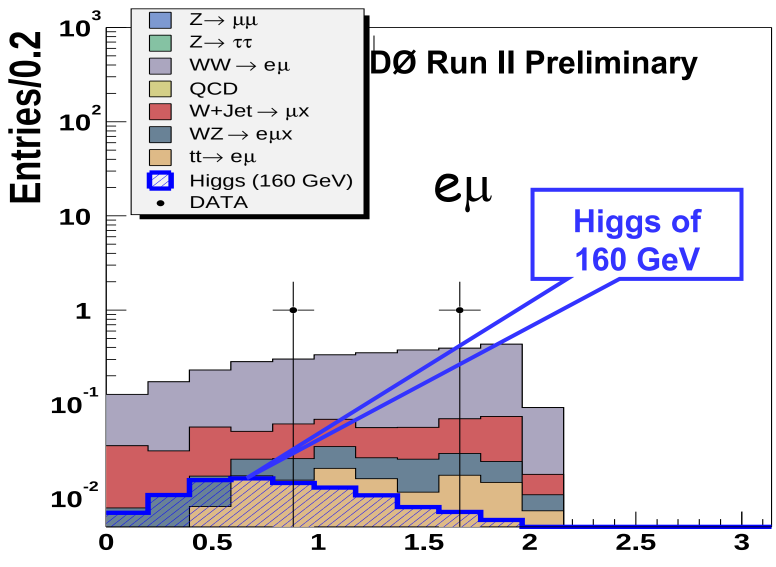


WW	W+jets	WZ	tt
2.51±0.05	0.34±0.02	0.11±0.01	0.13±0.01

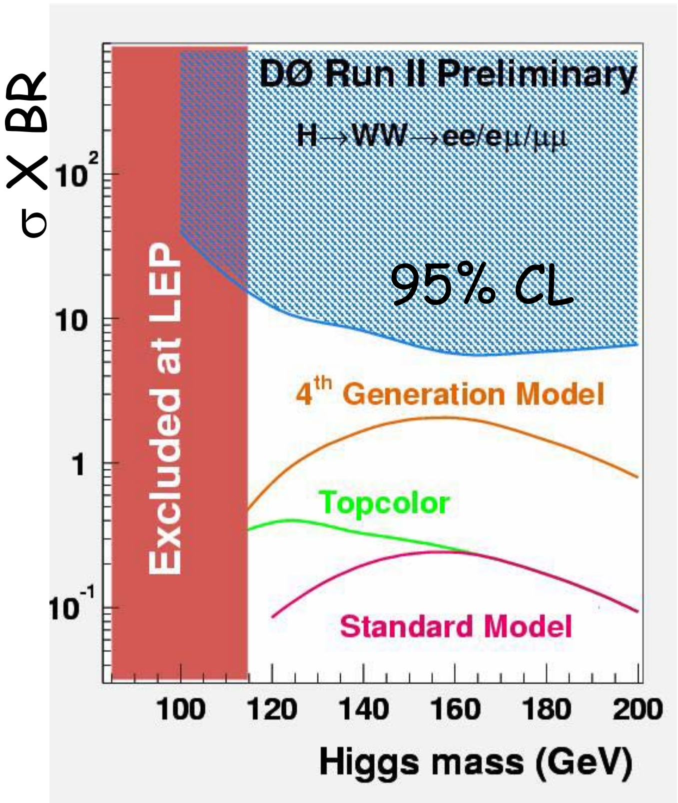
Can't reconstruct mass due to presence 2 neutrinos

$H \to WW^{(*)} \to l^+l^-\nu\nu$

	ee	eμ	μμ
Observed	2	2	5
Expected	2.7±0.4	3.1±0.3	5.3±0.6



After all Cuts



Signal acceptance is ~ 0.02 – 0.2 depending on the Higgs mass/final state

Top Quark

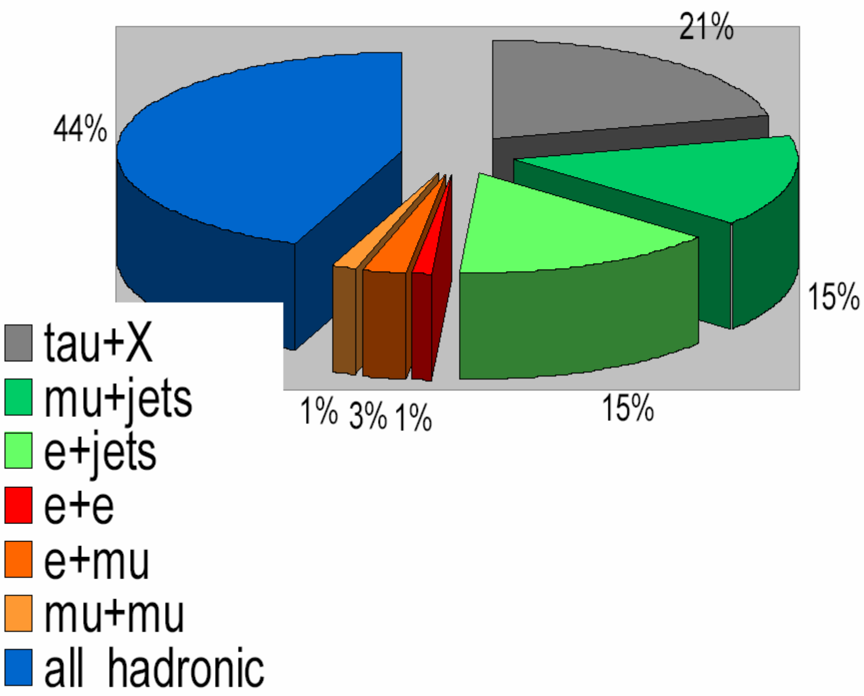
Precision Measurement in Run 2

Cross Section

Cross Check SM with M_{Top}
"Rare" Decays

Mass

Constrain M_{Higgs}



Run 1 World Average Top Mass
Run 2 Cross Sections

All jets, dilepton, l+jets

Stay tuned for τ's

Di-Lepton Top Cross Section

Small cross section
Relatively free of SM backgrounds

$\int \mathcal{L}$ (pb^{-1})	ee	$e\mu$	$\mu\mu$
total	156.33	142.73	139.58

SM Backgrounds

$Z/\gamma \rightarrow l^+l^- jj$
$WW \rightarrow l^+l^- jj$

ALPGEN+Pythia

Instrumental Fakes

$\not{E}_T$ Fakes
Isolated Lepton Fakes

Estimated on data

Category	ee	$\mu\mu$	$e\mu$	$\ell\ell$
Z/γ^*	0.15 ± 0.10	2.04 ± 0.49	0.47 ± 0.17	2.66 ± 0.53
WW	0.14 ± 0.08	0.10 ± 0.04	0.29 ± 0.06	0.53 ± 0.11
Fakes	0.91 ± 0.30	0.46 ± 0.20	0.19 ± 0.06	1.56 ± 0.36
Total background	1.20 ± 0.33	2.61 ± 0.53	0.95 ± 0.19	4.76 ± 0.65
Expected signal	1.39 ± 0.19	0.83 ± 0.15	3.77 ± 0.44	5.99 ± 0.50
SM expectation	2.59 ± 0.38	3.44 ± 0.55	4.73 ± 0.49	10.76 ± 0.83
Selected events	5	4	8	17

Cuts

ee

Cut	Data	Total	Fakes	$Z/\gamma^* \to \tau\tau$	WW	$t\bar{t}$
$N_{ele}^{p_T>20} \geq 2$ + $\not\!\!E_T$ cut	17	14.29±2.47	10.11±2.35	0.22± 0.06	2.05±0.73	$1.91^{+0.18}_{-0.21}$
$N_{jets} \geq 2$	6	$3.92^{+0.57}_{-0.60}$	1.89±0.51	$0.19^{+0.08}_{-0.14}$	$0.27^{+0.16}_{-0.13}$	$1.57^{+0.18}_{-0.24}$
$N_{jets}^{p_T>20} \geq 2$	5	$2.59^{+0.36}_{-0.40}$	0.91±0.30	$0.15^{+0.07}_{-0.12}$	$0.14^{+0.08}_{-0.07}$	$1.39^{+0.16}_{-0.22}$

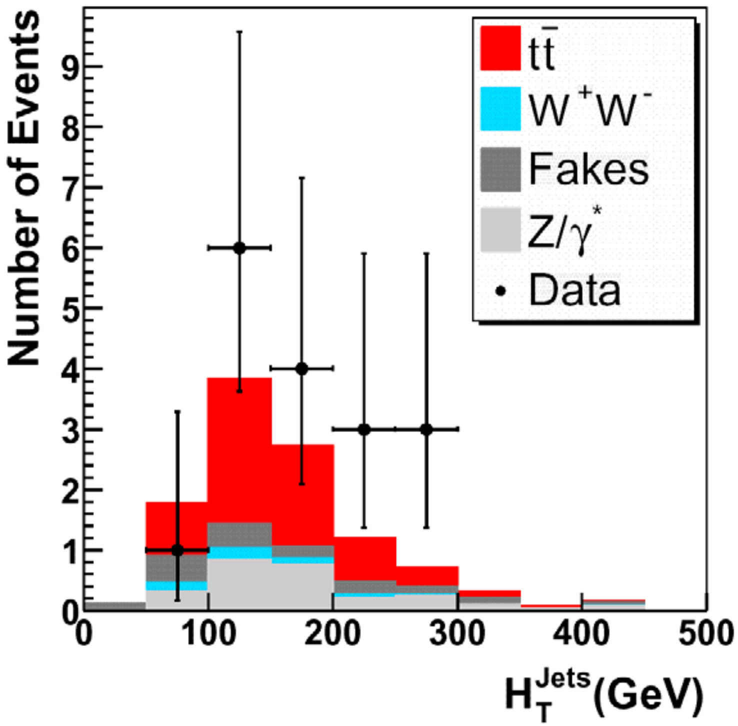
μμ

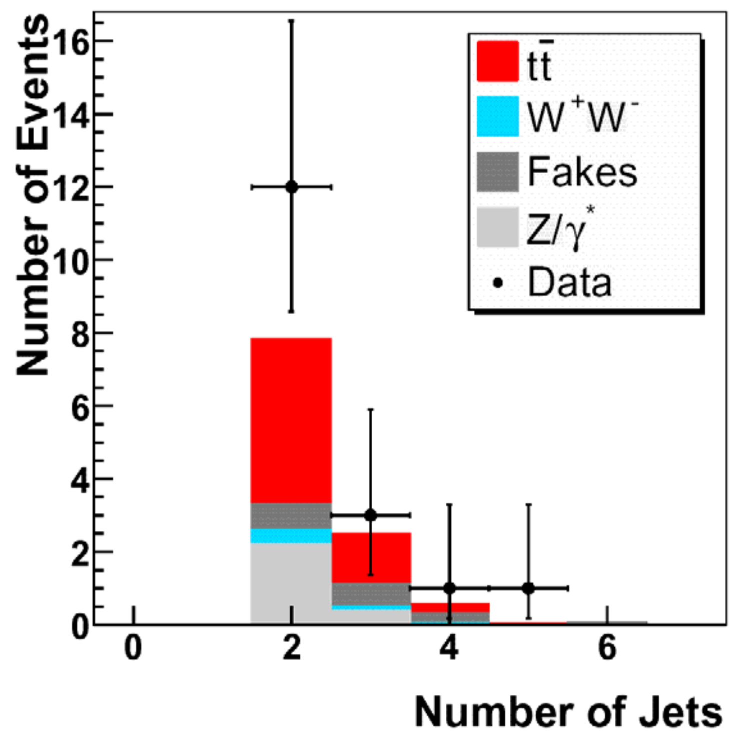
Criteria	Data	Total	Fakes	Z/γ^*	WW	$t\bar{t}$
Preselection cuts	128	133.8 ± 26.0	7.68 ± 1.42	124.0 ± 25.9	0.276 ± 0.102	1.87 ± 0.34
$\Delta\phi(\mu_{leading}, \not\!\!E_T) < 165^\circ$ and $M_{\mu\mu}$ cuts	22	27.6 ± 4.8	3.66 ± 0.59	22.7 ± 4.8	0.199 ± 0.074	1.07 ± 0.20
$H_T^\mu > 120$ GeV cut	17	18.2 ± 3.1	2.49 ± 0.47	14.5 ± 3.1	0.152 ± 0.057	1.04 ± 0.19
$\not\!\!E_T > 35$ GeV cut	4	$3.44 \pm .55$	0.46 ± 0.20	2.04 ± 0.49	0.104 ± 0.040	0.83 ± 0.15

eμ

Cut	Data	Total	Fakes	$Z/\gamma^* \to ll + jets$		$WW \to e\mu$	$t\bar{t}$
				$Z/\gamma^* \to \tau\tau$	$Z/\gamma^* \to \mu\mu$		
One tight EM and one isolated muon with $\Delta R(e,\mu) > 0.25$	113	$110.79^{+6.70}_{-6.32}$	9.39 ± 2.91	$54.49^{+4.76}_{-4.33}$	$30.43^{+3.56}_{-3.39}$	$10.48^{+0.96}_{-1.01}$	$5.98^{+0.47}_{-0.48}$
$\not\!\!E_T > 25$ GeV	29	$23.80^{+2.17}_{-2.37}$	3.80 ± 1.18	$3.93^{+0.72}_{-0.81}$	$2.95^{+0.91}_{-0.95}$	$7.74^{+1.32}_{-1.58}$	$5.38^{+0.39}_{-0.44}$
Two jets with $p_T > 15$ GeV	10	$6.57^{+0.56}_{-0.54}$	0.49 ± 0.15	$0.95^{+0.34}_{-0.30}$		$0.67^{+0.12}_{-0.13}$	$4.45^{+0.38}_{-0.40}$
Two jets with $p_T > 20$ GeV	8	$5.65^{+0.51}_{-0.56}$	0.31 ± 0.09	$0.71^{+0.27}_{-0.23}$		$0.46^{+0.11}_{-0.11}$	$4.17^{+0.42}_{-0.49}$
$H_T^{leading\ lepton} > 140$ GeV	8	$4.73^{+0.46}_{-0.51}$	0.19 ± 0.06	$0.47^{+0.18}_{-0.16}$		$0.29^{+0.06}_{-0.06}$	$3.77^{+0.42}_{-0.47}$

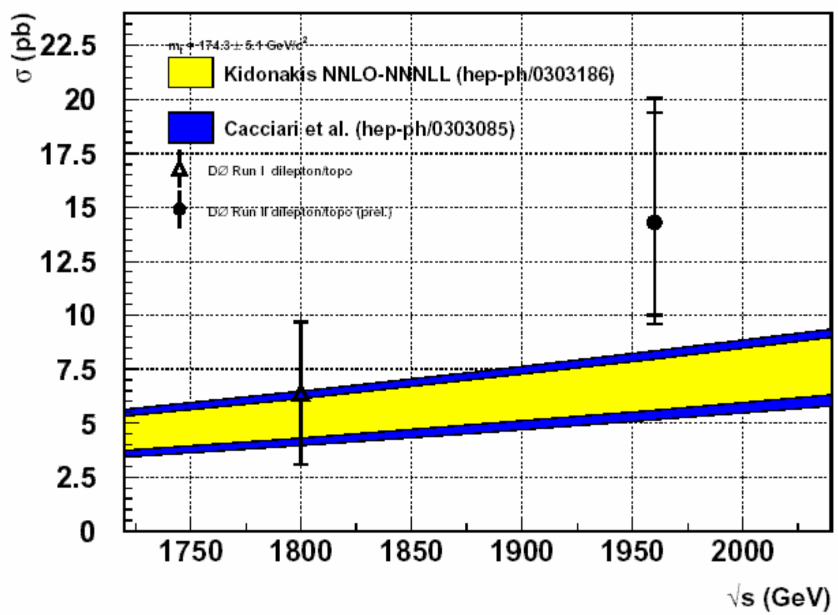
Dilepton Cross Section





Dilepton Cross Section

$$\begin{aligned}
ee &: \quad \sigma_{t\bar{t}} = 19.1^{+13.0}_{-9.6}\ (\text{stat})\ ^{+3.7}_{-2.6}\ (\text{syst})\ \pm 1.2\ (\text{lumi})\ \text{pb};\\
\mu\mu &: \quad \sigma_{t\bar{t}} = 11.7^{+19.7}_{-14.1}\ (\text{stat})\ ^{+7.9}_{-5.0}\ (\text{syst})\ \pm 0.8\ (\text{lumi})\ \text{pb};\\
e\mu &: \quad \sigma_{t\bar{t}} = 13.1^{+5.9}_{-4.7}\ (\text{stat})\ ^{+2.2}_{-1.7}\ (\text{syst})\ \pm 0.9\ (\text{lumi})\ \text{pb};\\
\text{dilepton} &: \quad \sigma_{t\bar{t}} = 14.3^{+5.1}_{-4.3}\ (\text{stat})\ ^{+2.6}_{-1.9}\ (\text{syst})\ \pm 0.9\ (\text{lumi})\ \text{pb}.
\end{aligned}$$



Cross section shows some excess which is still consistent with the standard model expectation. We are looking forward to collecting more data!!

Lepton + Jets

Systematics Driven Method

LP'03 results were close to being systematics driven

Fit shapes from likelihood discriminate of signal and background

1. Preselection cuts removes all but W+Jets
2. Determine Topological Variables ← No B-tagging
3. Create Likelihood Discriminent
4. Fit data to combinations of backgrounds and signal

Preselection Cuts include NJets>=4, etc.

Lepton + Jets

Topological Variables

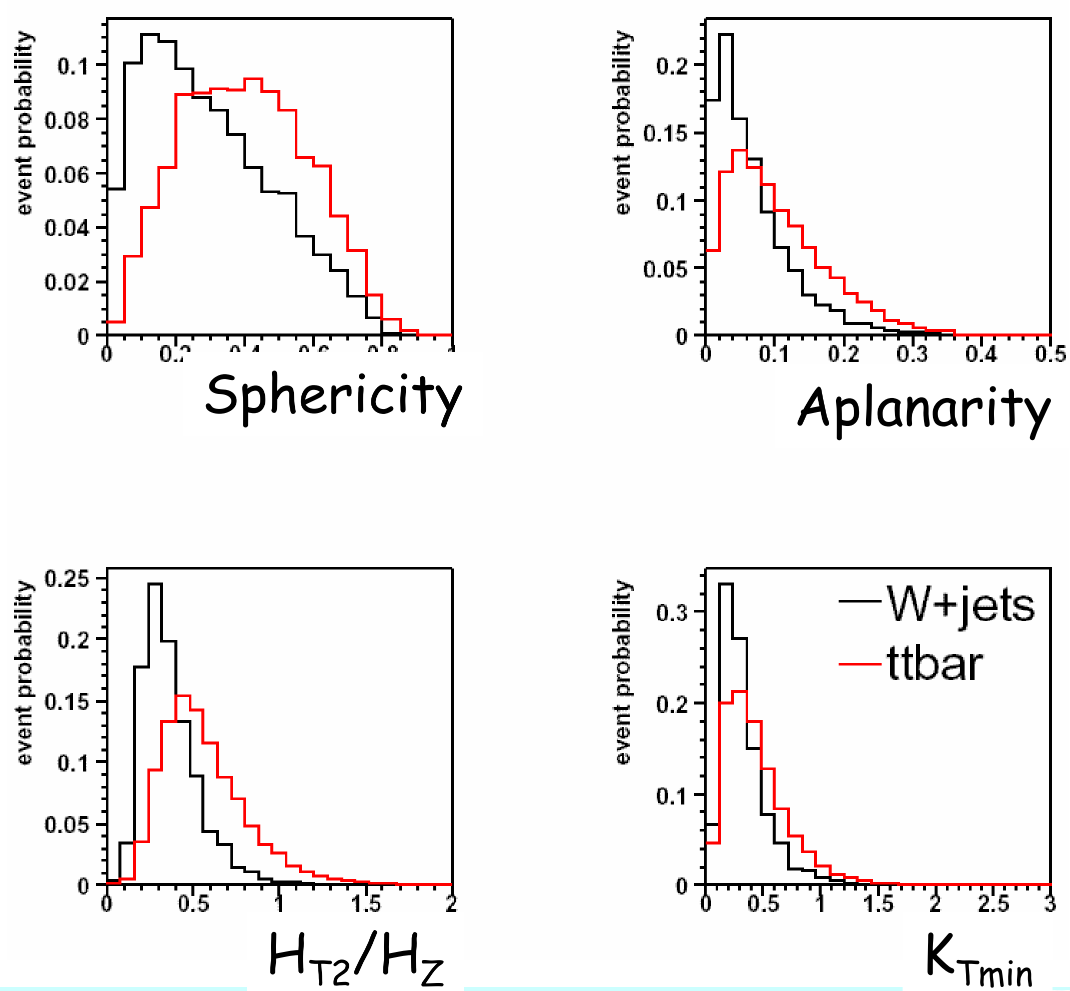
- Good S:B
- Minimize JES
- Small Correlations

H_{T2}/H_Z

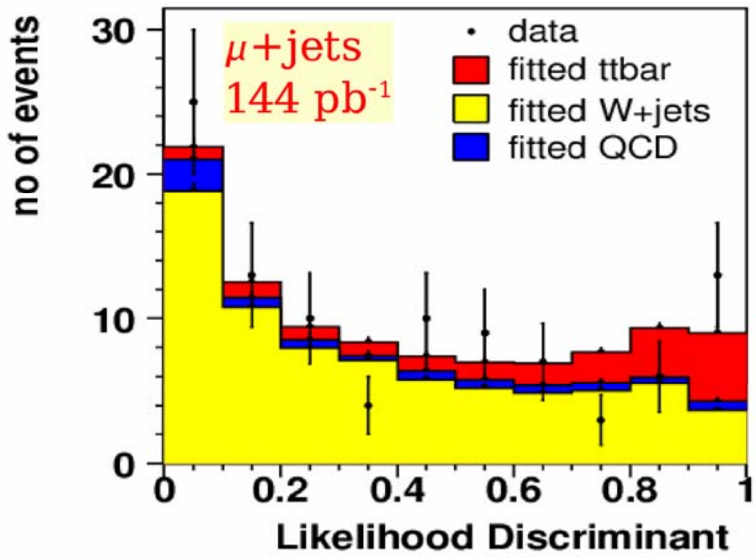
Centrality
H_T of all but leading jet

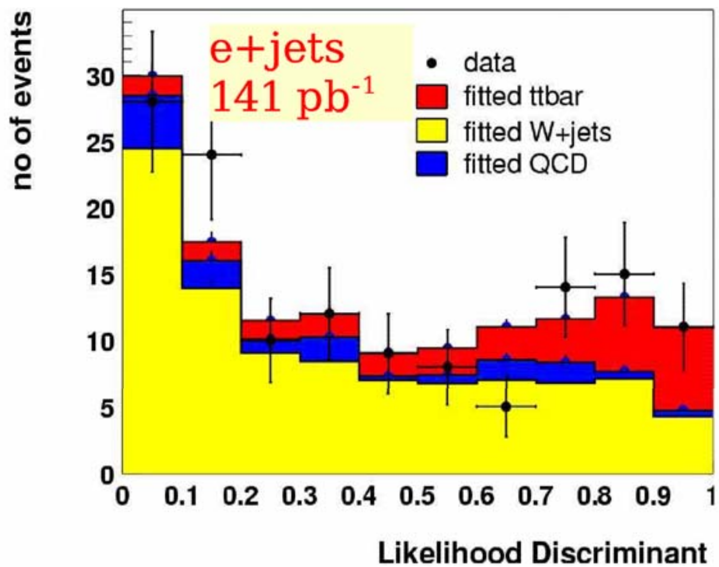
K_{Tmin}

K_T of #4 jet relative
to #3 jet.



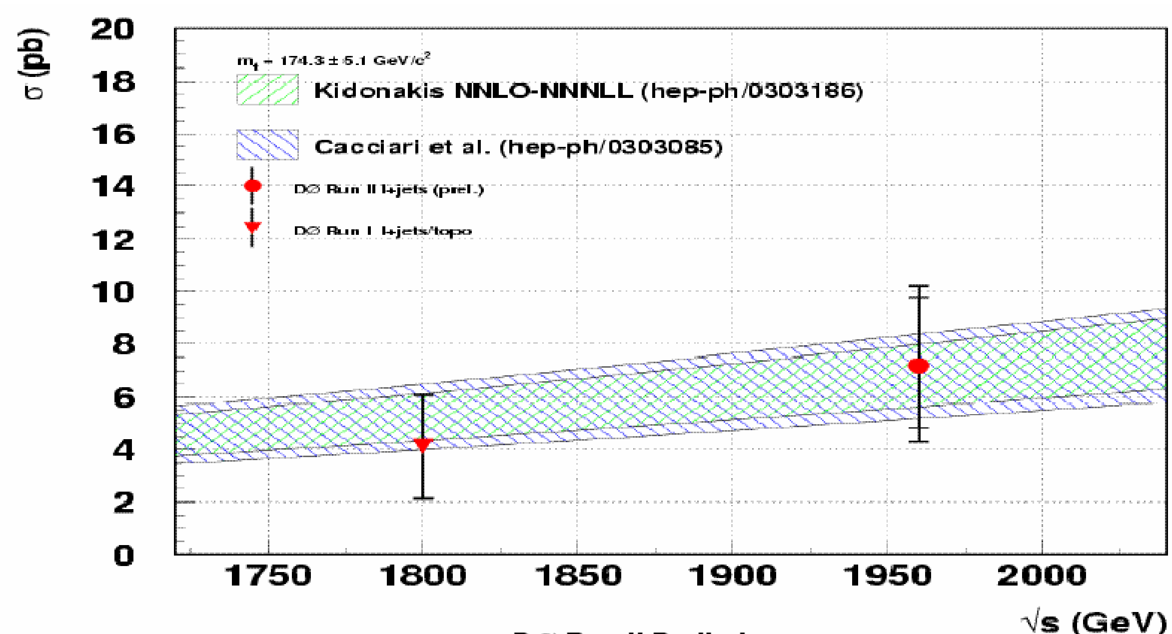
Lepton + Jets





	muons	electrons
Nev	100	136
fitted N^{W}	74.7 + 12.7 – 12.0	94.6 + 15.8 - 15.0
fitted N^{QCD}	7.1 + 0.9 – 0.9	14.1 + 1.2 - 1.2
fitted N^{tt}	17.8 + 9.9 – 8.7	27.5 + 12.7 - 11.7

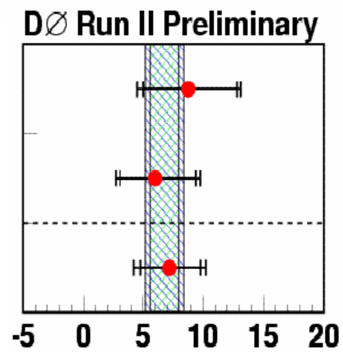
Lepton + Jets



$8.8^{+4.1}_{-3.7}\,(stat)\ ^{+1.6}_{-2.1}\,(sys)\ \pm 0.57(lumi)$ pb

$6.0^{+3.4}_{-3.0}\,(stat)\ ^{+1.6}_{-1.6}\,(sys)\ \pm 0.39(lumi)$ pb

$7.2^{+2.6}_{-2.4}\,(stat)\ ^{+1.6}_{-1.7}\,(sys)\ \pm 0.47(lumi)$ pb



e+Jets

μ+Jets

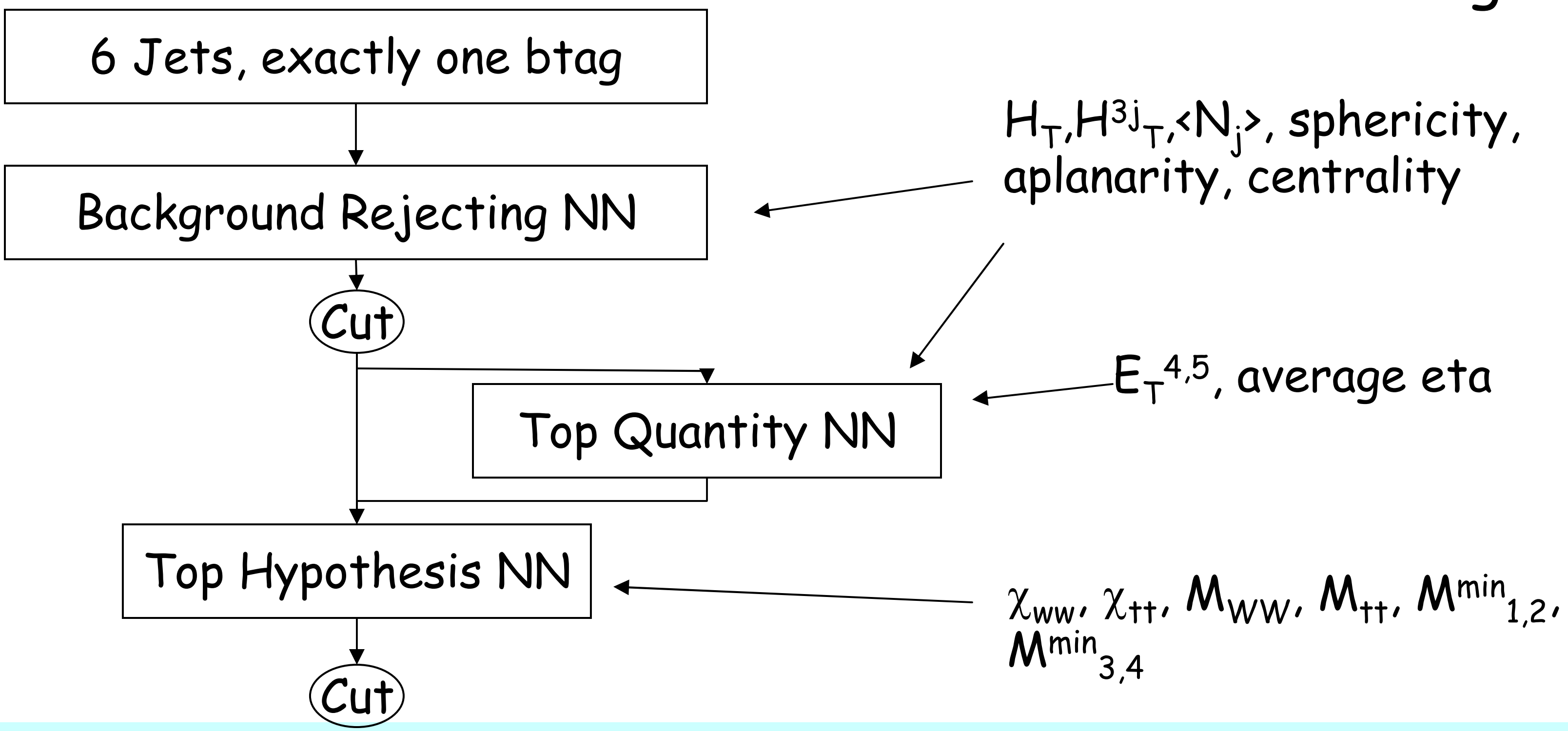
Total

All Jets Cross Section

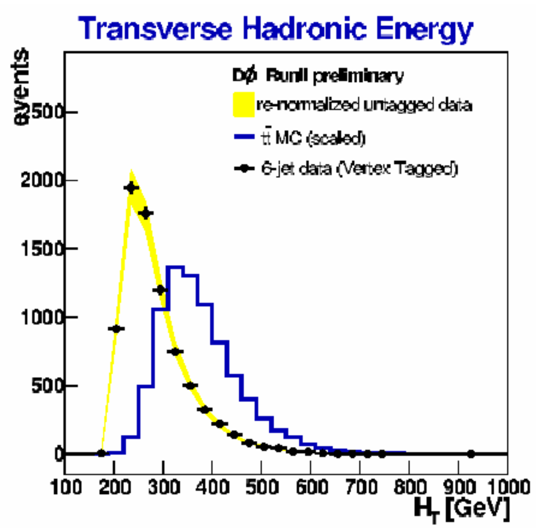
46% of ttbar production
QCD is many orders mag greater

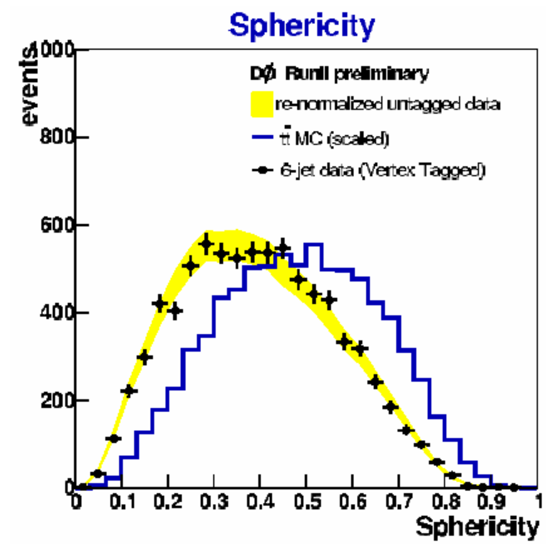
Simple Cuts aren't enough!

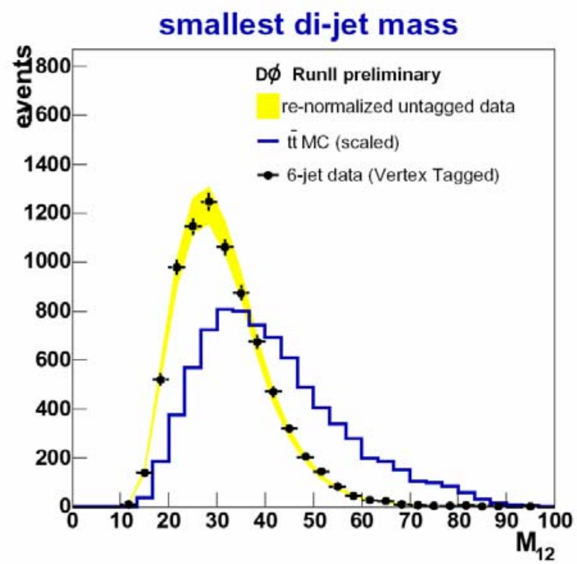
NN are trained on data for background, and ttbar MC for signal



Discriminating Variables







Background model is data-derived

Variables are designed to address different aspects of the background

Energy Scale – H_T, sqrt(s)

Soft non-leading Jets – H^{3j}_T, $E_T^{5,6}$, $\langle N_j \rangle$

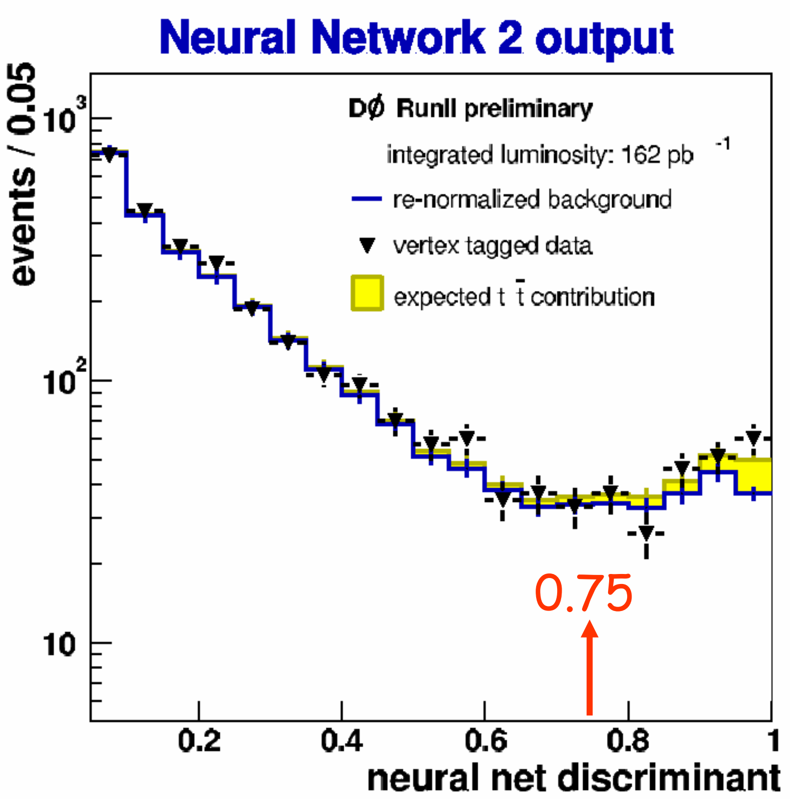
Event Shape – Sphericity, aplanarity

Rapidity – Centrality, $\langle \eta^2 \rangle$

Top Properties – Top and W Mass Likelihood, M_{WW}, M_{tt}, min dijet masses

JES Systematics

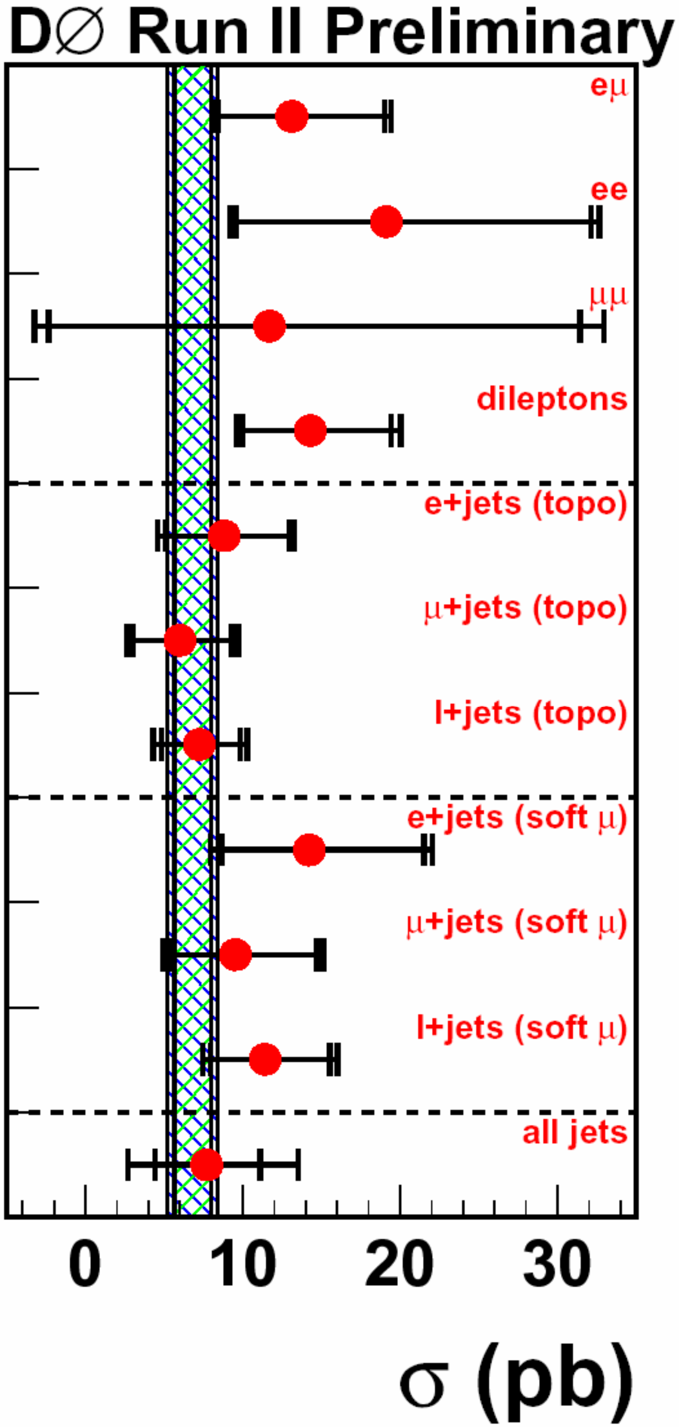
All Jets Cross Section



	Uncertainty (%)
Vertex ID	1
Jet ID	10
JES	28
Jes Resolution	0.6
Top Mass	7.6
Trigger	4
Tagging	4.0
Total	31

220 events pass all cuts
Expect 186 ± 5(stat) ± 7.5(sys)

$$\sigma(t\bar{t} \rightarrow jjjjjj) = 7.7^{+3.4}_{-3.3}(stat)^{+4.7}_{-3.8}(sys) \pm 0.5(lumi)\,pb$$

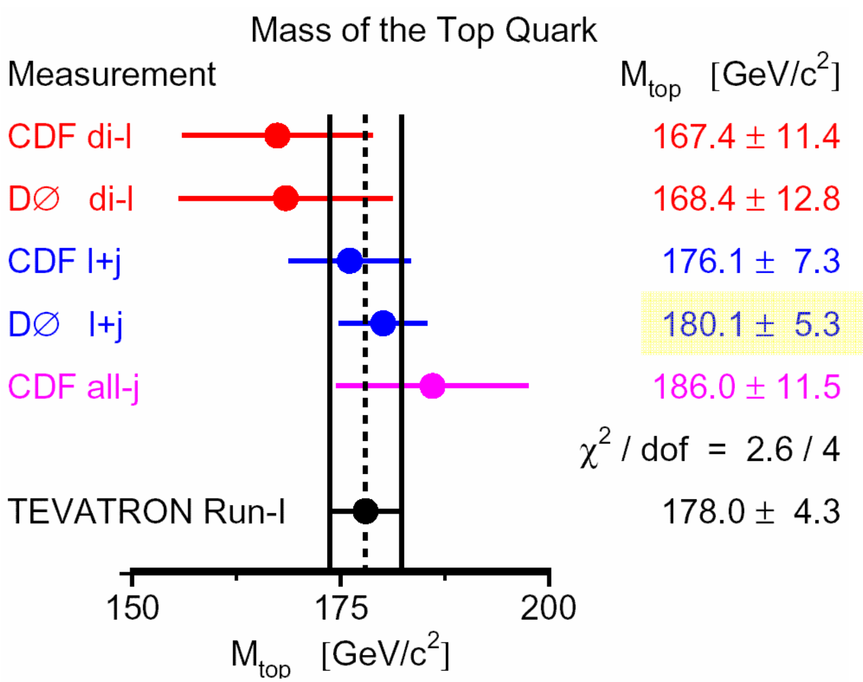


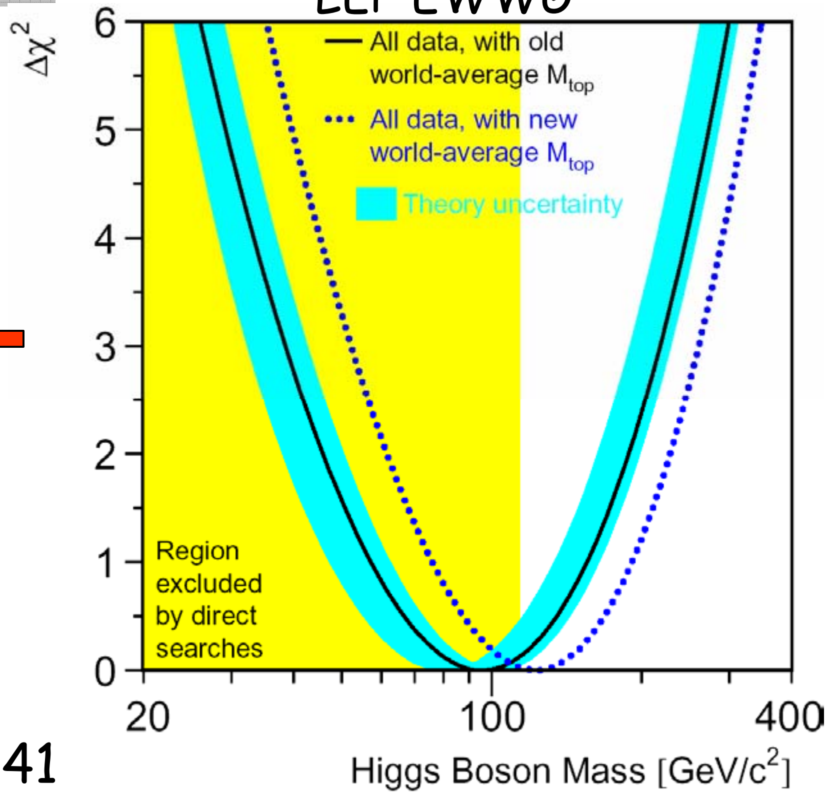
143 pb^{-1}	$13.1^{+5.9}_{-4.7}{}^{+2.2}_{-1.7}$	pb
156 pb^{-1}	$19.1^{+13.0}_{-9.6}{}^{+3.7}_{-2.6}$	pb
140 pb^{-1}	$11.7^{+19.7}_{-14.1}{}^{+7.9}_{-5.0}$	pb
140 pb^{-1}	$14.3^{+5.1}_{-4.3}{}^{+2.6}_{-1.9}$	pb
141 pb^{-1}	$8.8^{+4.1}_{-3.7}{}^{+1.6}_{-2.1}$	pb
144 pb^{-1}	$6.0^{+3.3}_{-3.0}{}^{+1.6}_{-1.6}$	pb
141 pb^{-1}	$7.2^{+2.6}_{-2.4}{}^{+1.6}_{-1.7}$	pb
92 pb^{-1}	$14.2^{+7.3}_{-5.6}{}^{+2.9}_{-2.8}$	pb
94 pb^{-1}	$9.5^{+5.2}_{-4.1}{}^{+2.1}_{-2.1}$	pb
92 pb^{-1}	$11.4^{+4.1}_{-3.5}{}^{+2.0}_{-1.8}$	pb
162 pb^{-1}	$7.7^{+3.4}_{-3.3}{}^{+4.7}_{-3.8}$	pb

Top Mass Combination

DØ New Run I Top Mass Result is now part of the TeV M_{Top} combination

(see Juan's April 25 2003 W&C)





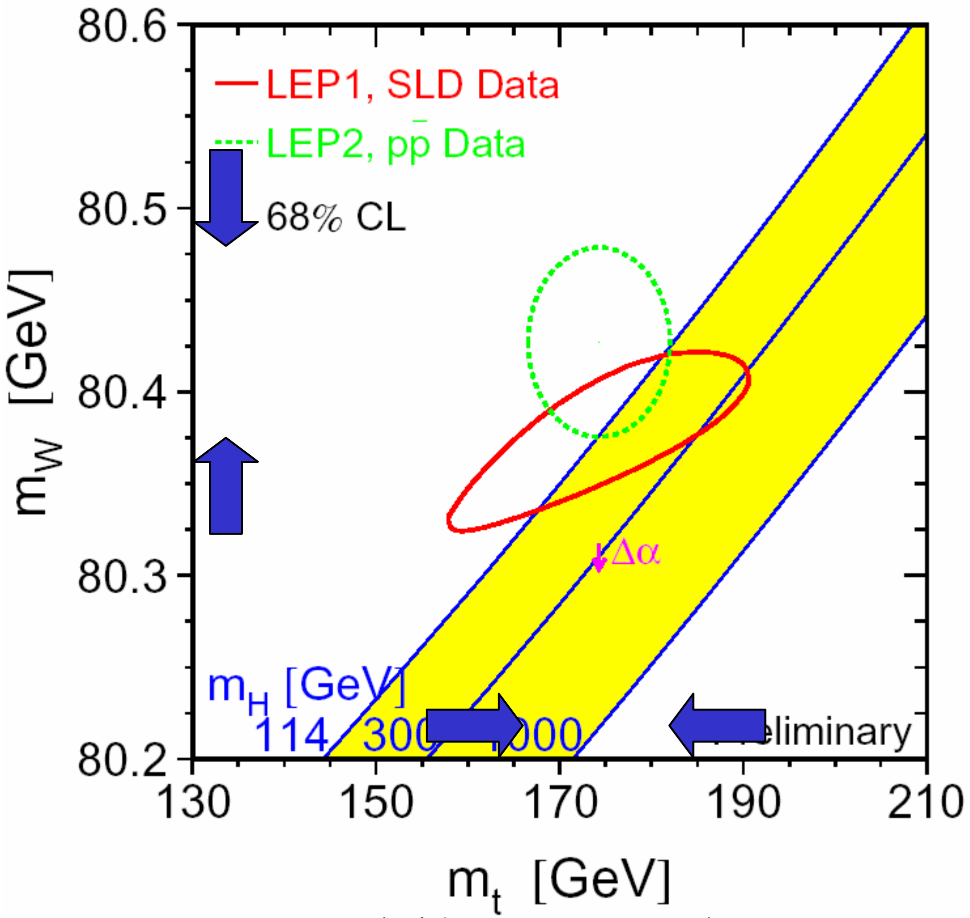
Old Combination M_t = 174.333 ± 5.141

Really want to talk about…

Squeezing Run 2 Top and W Mass Errors

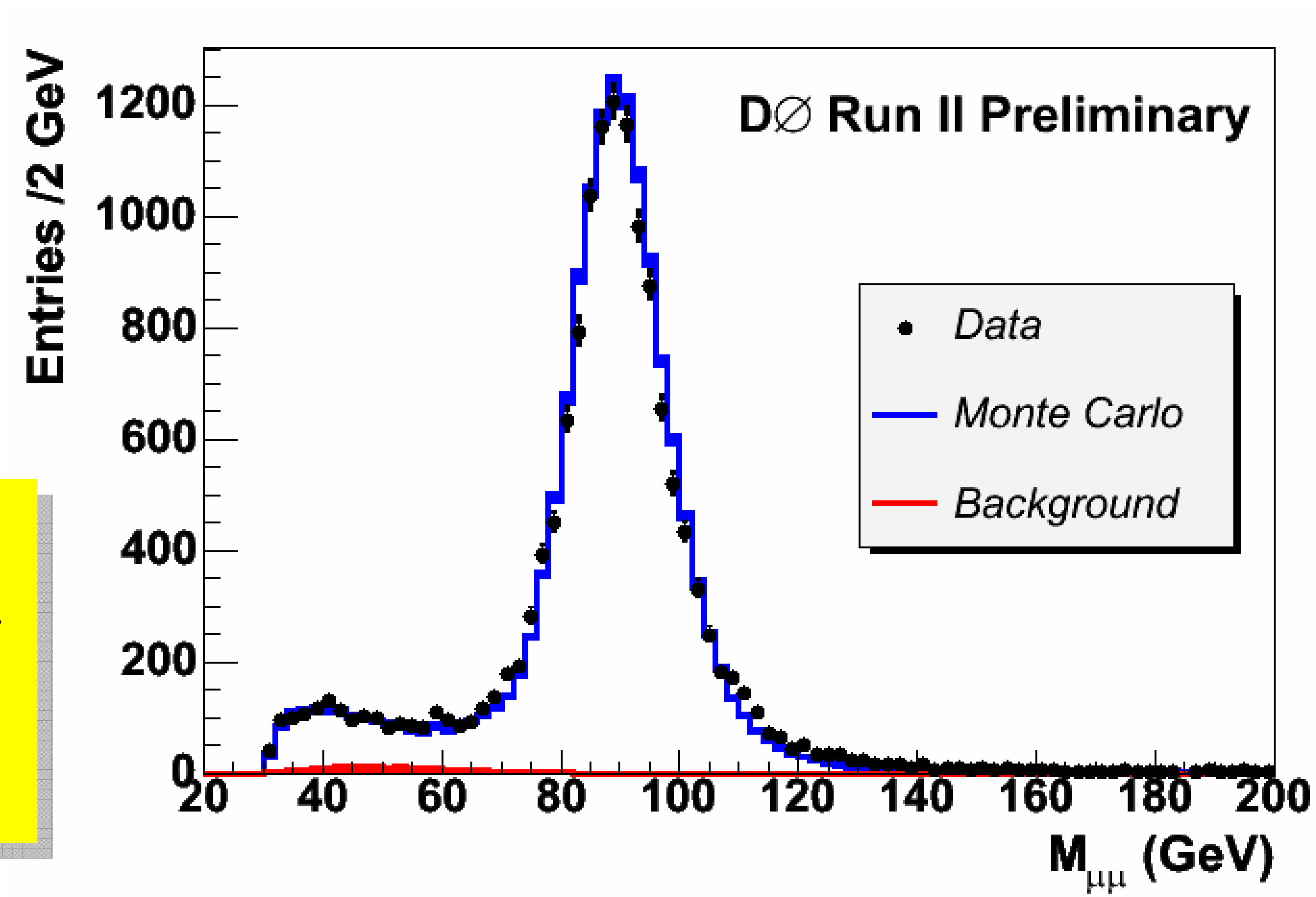
Extensive program in place

Coming to a Wine And Cheese near you soon…



(Old TeV Top Mass)

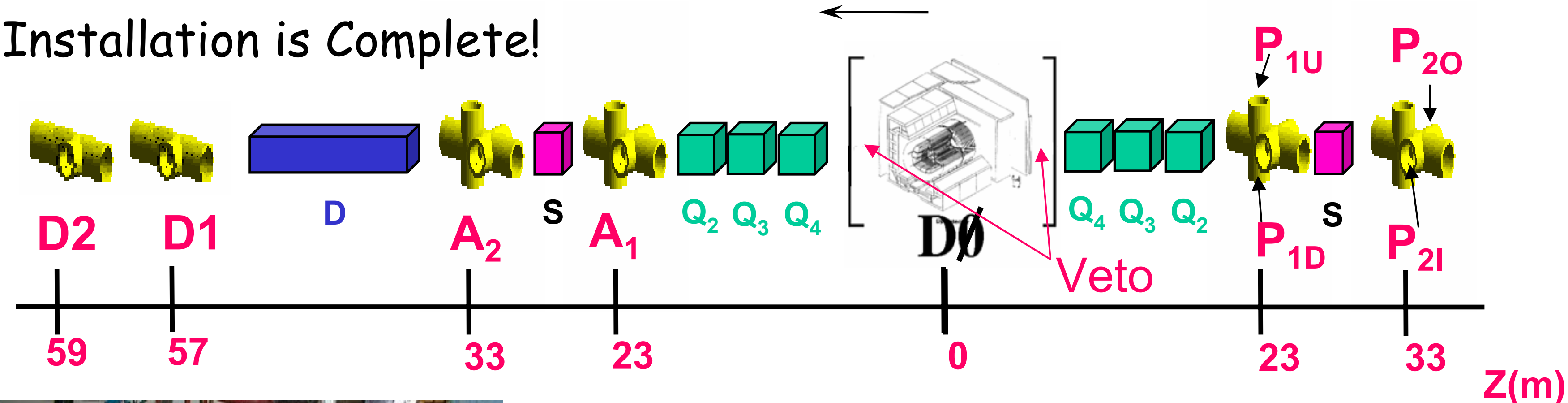
W/Z Cross Sections

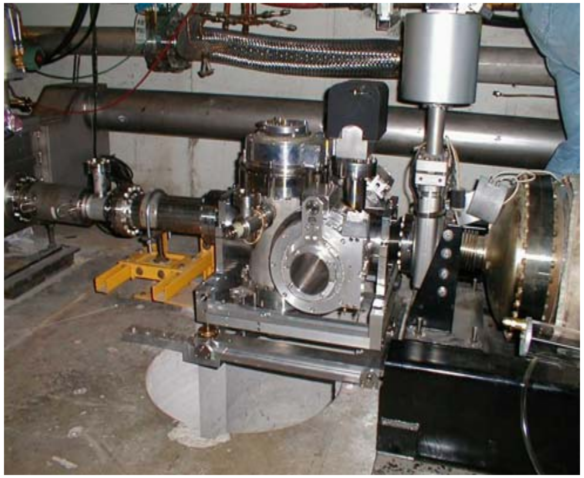


Not updating cross sections this time around, but we have a new sample and new analysis in advanced state of review

Forward Proton Detector

Installation is Complete!





9-17 mm from beam @ 30 m

$0.92 < t < 3$ GeV^2 @1960 GeV

Analysis in progress
dN/dT, diffractive jets

Single Top

Single Top Production gives you access to

- $B(t \rightarrow WB)$
- $|V_{tb}|$
- W Helicity
- Top Polarization
- Top Width
- Anomalous couplings
- Rare Decays

Preselect Events

↓

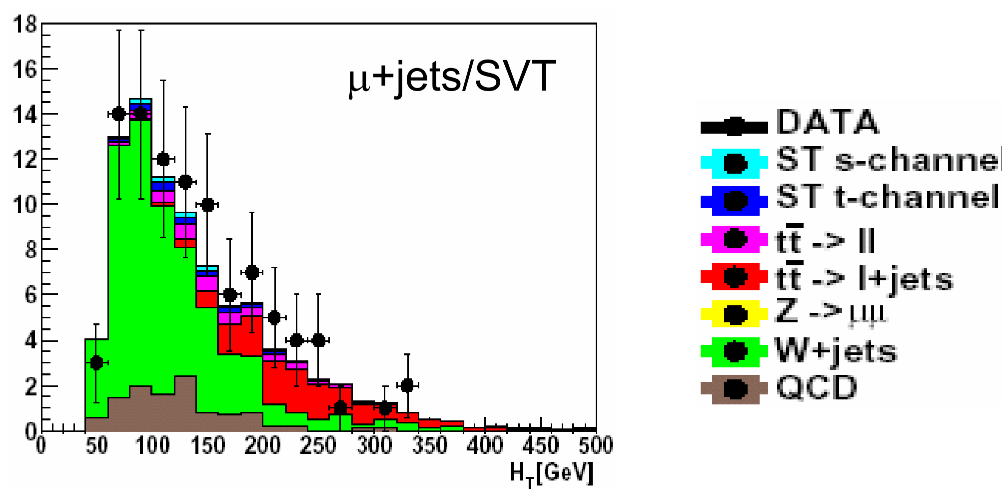
Apply BTagging

↓

Apply Topological Cuts

Backgrounds

QCD (fakes)	(Data)
W+Jets	(Data)
ttbar	(MC)



Expected Sensitivity

	Electron Channel			Muon Channel	
	SLT	*SVT*	*JLIP*	*SLT*	*SVT*
s-channel	0.67± 0.14	1.87± 0.46	1.88± 0.46	0.63± 0.13	1.38± 0.35
t-channel	0.95± 0.20	3.14± 0.76	3.20± 0.82	0.88± 0.19	2.19± 0.56
tt	9.60± 1.65	23.31± 4.90	24.50± 5.48	8.43± 1.44	18.57± 3.75
non-top	31.1± 5.2	63.5± 12.3	71.7± 13.7	34.3± 5.1	67.0± 11.8
Total expected	42.4± 5.4	91.9± 13.3	96.3± 14.8	44.2± 5.3	89.2± 12.4
Observed	**49**	**88**	**99**	**48**	**94**

We have not applied final topological cuts yet!

Expected Limit!

	Without Systematics	***With Systematics***
σ_s *(pb)*	<6.4	**<13.8**
σ_t *(pb)*	<9.0	**<19.8**
σ_{s+t} *(pb)*	<7.9	**<15.8**

Already better than Run 1 limits!

Conclusions

Conclusions

- Taking advantage of the Data
  - QCD program is under way with jet cross sections and studies.
  - Electro weak is moving to the next level of accuracy
  - Higgs is demonstrating an understanding of the most important backgrounds
  - Top has remeasured the cross section.
    - Mass result will appear soon.
  - Many new analyses and conference results.
    - More in the pipeline!
  - Write-ups available for all analyses
- Improvements On Tap
  - JES
  - Already have another 70 pb^{-1} on tape.
  - New Ideas…

Jet Cone Algorithm

"particle" = {experiment: calorimeter towers / MC: stable particles / pQCD: partons}

three parameters: $R_{\text{cone}} = 0.7$, $p_{T\,\text{min}} = 8$ GeV, overlap fraction $f = 50\%$

- Use all particles as **seeds**
  — make cone of radius $\Delta R = \sqrt{(\Delta y^2 + \Delta\phi^2)} < R_{\text{cone}}$ around seed direction
  — proto jet: add particles within cone in the "E-scheme" (adding four-vectors)
  — iterate until stable solution is found with: cone axis = jet-axis
- Use all **midpoints** between pairs of jets as **additional seeds** $\Longrightarrow$ infrared safety!!!
  — (repeat procedure as described above)

- Take all solutions from the first two steps:
  — remove identical solutions
  — remove proto-jets with $p_{T\,\text{jet}} < p_{T\,\text{min}}$
- Look for jets with **overlapping cones**:
  — merge jets, if more than a fraction f of $p_{T\,\text{jet}}$ is contained in the overlap region
  — otherwise split jets: assign the particles in the overlap region to the nearest jet
  ($\rightarrow$ and recompute jet-axes)

Jet Cone Algorithm

the cone algorithm used by DØ in Run I differed in the following ways:

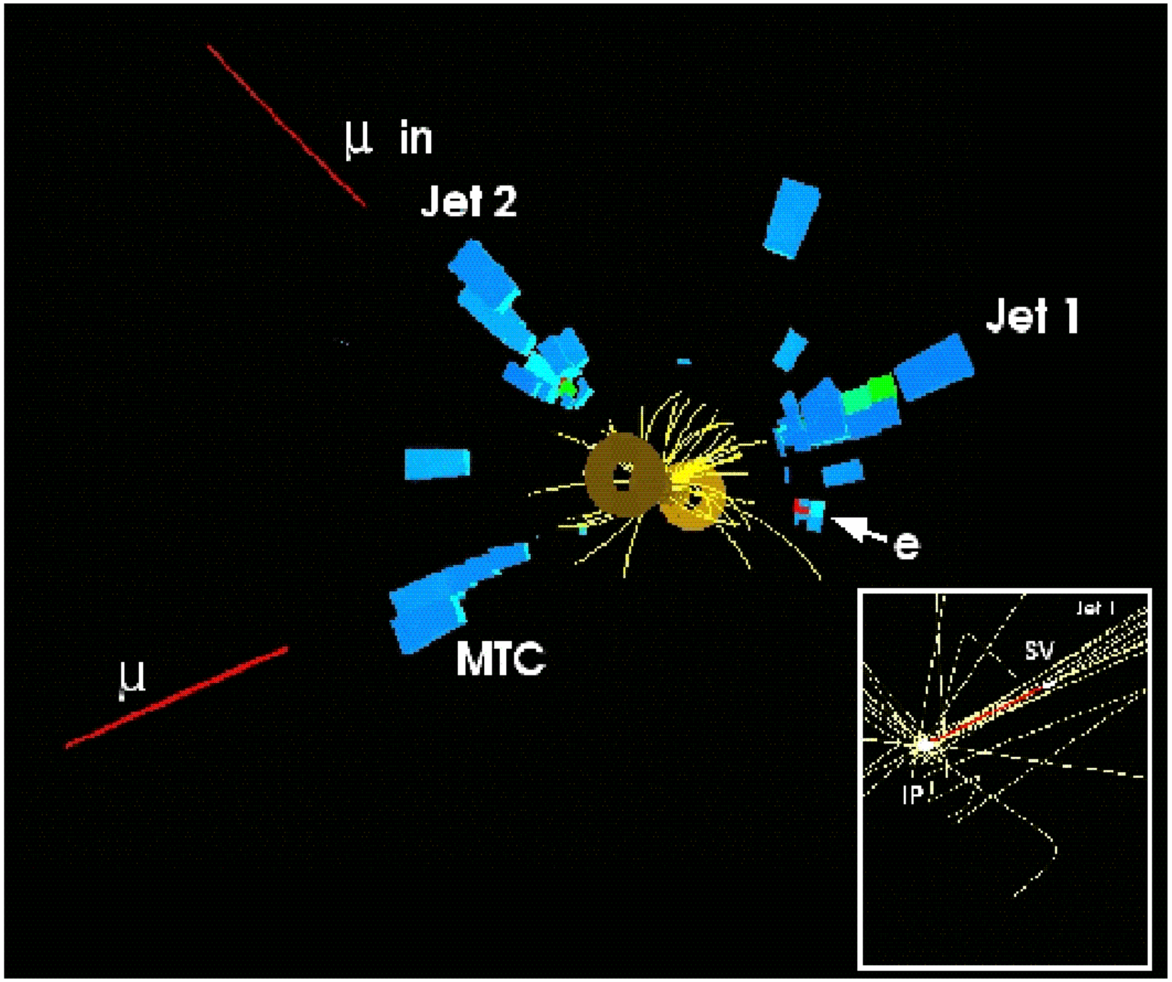
- Particles were combined to jets in the "E_T-scheme" ("snowmass convention") instead of the "E-scheme" (adding four-vectors)

  $\Rightarrow$ in Run I by definition jet four-vectors were massless
  $\rightarrow$ pseudorapidity η was used instead of rapidity y
  $\rightarrow$ transverse energy $E_T = E \cdot \sin\theta$ was used instead of transverse momentum p_T

  please note: $E_T^{E_T-\text{scheme}} \geq p_T^{E-\text{scheme}}$ and $M_{\text{dijet}}^{E_T-\text{scheme}} \leq M_{\text{dijet}}^{E-\text{scheme}}$

- no midpoints were used as additional seeds
  $\Rightarrow$ procedure not infrared safe $\Rightarrow$ no predictions from perturbative QCD possible

Dilepton Event



Multi-jet Background

Full Multijet Sample

Calculate TRF (p_T & 3 Regions of η)

2-Tagged Sample

Apply TRF

3-Tagged Jet Distribution

bbbb, zbb

Fit outside to real 3 Tagged Distribution

Fitted Background

Shapes are similar, so fit should take care of them to first order